CENTRAL-STATION ELECTRIC SERVICE

SAMUEL INSULL

CENTRAL-STATION ELECTRIC SERVICE

FALK PHOTO, NEW YORK

To Samuel Insull

My friend and companion of many years in the pioneering of Incandescent electric lighting

Thomas A. Edison

Orange N.J. Oct 25th 1904

CENTRAL-STATION

ELECTRIC SERVICE

ITS COMMERCIAL DEVELOPMENT AND
ECONOMIC SIGNIFICANCE AS SET FORTH IN
THE PUBLIC ADDRESSES (1897-1914) OF

SAMUEL INSULL

FELLOW OF THE AMERICAN INSTITUTE
OF ELECTRICAL ENGINEERS, MEMBER OF THE
BRITISH INSTITUTION OF ELECTRICAL ENGINEERS,
MEMBER OF THE FRANKLIN INSTITUTE, PAST PRESIDENT OF
THE NATIONAL ELECTRIC LIGHT ASSOCIATION, PAST
PRESIDENT OF THE ASSOCIATION OF EDISON
ILLUMINATING COMPANIES, ETC.

EDITED WITH AN INTRODUCTION BY
WILLIAM EUGENE KEILY
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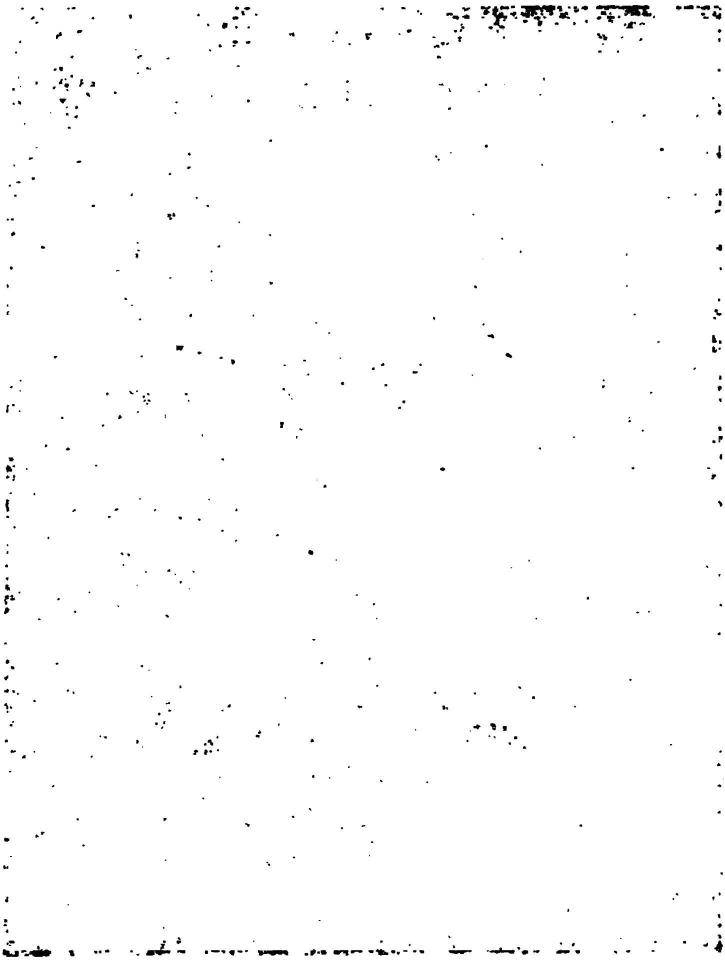
OF ELECTRICAL ENGINEERS, ETC.

ILLUSTRATED

CHICAGO
PRIVATELY PRINTED
1915



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One thousand one hundred and twenty copies of this book have been printed for private circulation.

This copy is No. 371
and is presented by Mr. Insull to

The Library of
University of Wisconsin.

TO

MY MOTHER

IN GRATEFUL RECOGNITION OF
HER AFFECTIONATE AND
SYMPATHETIC ENCOURAGEMENT

S. I.

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FOREWORD

Some of the addresses given on the following pages have been printed in pamphlet form. Several months ago, when the question arose of reprinting such of these as were out of print, I decided to go a step farther and to print in a book, for private circulation, a collection of speeches that I have delivered on subjects bearing on Central-Station Electric Service. The present volume is the result of that determination. It is my hope that some of the material in these addresses is worthy of preservation in a permanent record, and that the studies which I have made in connection with my own work in the conduct of central-station enterprises may, if placed at the disposal of students and younger men coming into the industry, help these future managers and executives to solve the many problems with which they will have to deal. I also venture to express the belief that some of the addresses may be of use to the future historians of the industry, my connection with which I cherish with what I trust will be considered a pardonable pride.

The careful reader may find some divergences of opinion in the text of this volume. It should be borne in mind that the industry is the development of but a few years, relatively, and that to a large extent those engaged in it, certainly on the commercial side, have had to blaze their own trails. Thus, if different statements in my addresses appear contradictory, the cause may be found in the changes of opinion which greater experience often brings.

It has been my good fortune to be associated with the central-station industry for more than a generation, Sunday of this week being the thirty-fourth anniversary of my arrival in New York from England and of my entering the service, as private

secretary, of the father of the industry, Mr. Thomas A. Edison, then about to begin the installation of the first central station, in New York. Those who take the trouble to read the following chapters will find that the name of Edison occurs quite frequently. I have no apology to make for that fact. For thirty-six years — during my entire career in this country and for two years in London in connection with Mr. Edison's European business — it has been my privilege to serve under the banner bearing his name. For eleven years — from March, 1881, to June, 1892 — I had the great advantage of intimate personal association with, and teaching and advice from, the great inventor whose name must for all time be associated with the central-station industry, which is one of the many monuments to his genius, resourcefulness and unrivaled capacity for work. These remarks may explain why I deem it a privilege to present as the frontispiece of this volume a reproduction of my favorite photograph of Mr. Edison as a slight indication of my affectionate esteem for the man.

The literary and mechanical supervision of the book has been entrusted to my friend Mr. William Eugene Keily, an experienced writer on electrical subjects, who for many years has evinced a sympathetic interest in the ideas advanced in these addresses. I provided Mr. Keily with copies of all of the addresses that I had delivered and of which the text was available, and asked him to select from those placed at his disposal such as he deemed suitable to include in this volume. It is proper that mention should be made also of the assistance I have received from the engineering and statistical staff of the Commonwealth Edison Company in preparing the data and and curves used by me in my various addresses.

SAMUEL INSULL.

Chicago, March 6, 1915.

EDITOR'S INTRODUCTION

As one who has had something to do with the journalistic work connected with the development of the art and the industry which have been based on the science of electricity, it has been a great pleasure to me to prepare for the press the present collection of the public utterances of Samuel Insull. Quite apart from any interest which may attach to the personality of the man, this book should serve a useful purpose. It should have a value — a unique value, I think — as presenting in convenient form dissertations on the modern concept of the economics of central-station electric service, not by one who has only a theoretical knowledge of the subject, or a mere academic interest in it, but by one who has been intimately concerned in the expansion of the electrical industry for thirty-four years, and thus almost from its very beginning, and who for twenty-three years has stood in the first rank of operators of electric central-station properties. The work should have a practical value, therefore, to those who would learn of this important subject from one who can speak as the result of first-hand experience and study under actual conditions. Where else is to be found such a mass of practical operating data, such deductions and exhortations, such pleadings for the pure gospel of making and selling electricity on sound economic principles? Where else is available a series of papers like these from a man whose record makes him free of the right to speak to other electrical men? Nowhere else is there an undertaking of this precise character. And so, I believe, the book is intrinsically worth the making.

Obviously it would be out of place in a book having the genesis of this one to attempt an analysis of the qualifications of the author of these addresses. But there is no impropriety in

considering for a moment the place of the enterpriser — the *entrepreneur* of many economists — in public-utility work. What are the functions of an enterpriser? This question may be answered, perhaps, by quoting Mr. Halford Erickson, a member of the Railroad Commission of Wisconsin. Before a gathering of electrical men in June, 1914, Mr. Erickson read a carefully reasoned paper on "Regulation and Reasonable Returns." In the course of it the author expressed himself as follows:

Business is now largely carried on by enterprisers on borrowed capital on which interest is paid. * * * This condition has led to the separation of the functions of the capitalist and the enterpriser or employer and to a more complete analysis of the compensation that each of these factors receives. * * * The two functions are, in fact, often combined. * * * Profits have their source in the business ability, skill and foresight of the enterprisers, or in their management. The enterpriser is a sort of an economic buffer who bears the shock and often much of the loss in case of failure and who also reaps the credit and much of the profit in case of success. To successfully exercise the functions of an enterpriser a high order of ability is required. Such a man must have organizing capacity of a high order, be a good judge of men and have tact in dealing with them. He must have the command of financial resources and the ability to plan and execute commercial and industrial policies. He should also have the technical knowledge that is required to adopt the best methods, outline the most economical processes and to properly pass upon the materials and products. * * * The wages of management must be high enough to encourage men of the necessary ability and skill to enter the field. * * * The risks involved vary in their nature with variations in the character of the business. * * * They are always present, however, and must be assumed by every enterpriser. * * * In the long run the compensation for risks will not fall below the point at which a sufficient number of enterprisers are found who are willing to assume it.

The addresses which are collected in this book are the work of an enterpriser who has led the way to new conceptions of the economic function of central-station electric service. The great doctrines of concentrating facilities of production and trans-

mission, to reduce the community cost of making electricity; of utilizing the factor of diversity in demand incident to the varying electrical needs of a whole community or of a number of communities in a given area; of standing firm for monopoly in electric service (but a monopoly regulated by the state) that these economic benefits may be obtained; of reducing rates to small customers as well as large ones as fast as the economies effected in making and selling electricity will permit; of retaining a reasonable profit, but no more than a reasonable profit, for private ownership, because by private ownership alone, so far as experience has shown up to the present time, can these economies be effected; of being perfectly frank and open with the public and the public's representatives; of recognizing that the faithful and continued service of employees is entitled to more than a daily wage for daily work and providing such reserve accumulation that no deserving employee need fear want in his declining years — these are some of the principles laid down in the speeches gathered in this volume. Truly, the electric central-station industry has made great progress since the days of a pioneering that was characterized alike by the fine enthusiasms and the raw crudities of youth. It has, to a great extent, as we may believe, found itself; it knows more about itself, of the cost of producing its product and of how to sell it; it has passed from the time when electric lighting was its principal concern to an era of electric service, when the proportion of its energy used for lighting is becoming constantly smaller.

But there is a still more important aspect of the economics of electric service. What, for instance, is the position of this industry with respect to the *zeitgeist* — the spirit of the times? Is it responsive to the desire that the conditions of living may be ameliorated for all human beings as far as things from without can modify those conditions? Do the men representative of this particular manner of money-making recognize that in our queer social complexities unselfishness must be blended with selfishness to make a business successful? Or, if an antithesis may be allowed, do they realize that elec-

tricity is made for man and not man for electricity? In the judgment of the present writer a careful reading of the collected papers in this book will incline one to the belief that the above questions, broadly interpreted, must be answered in a manner to indicate that the representative electrical enterpriser, considered not only as an individual but also as a type, may be regarded as a man with a conscience. Perhaps it is not fanciful to say that through these speeches, but probably not in all cases as the result of premeditation, "one increasing purpose runs," and that that purpose is not alone the improvement of the electric-service industry but also the betterment in many ways of those served. This purpose is set forth, for example, in the last paragraph of the Association Island address on "Present and Future Distribution of Electrical Energy." The author says in that place that one likes to feel that he is "contributing something to the progress of the country in which he lives and of the people among whom he has his abiding place." Elsewhere he tells more fully of his conception of cheap electrical energy in every hamlet and of what it will mean to many toilers. One cannot relinquish this exploration of the deeper meanings of the book without voicing the reflection that if it is true that the man who causes two blades of grass to grow where one grew before is a benefactor of the race, then the man who effects a combination by which one watt of electrical energy serves the purpose of two is, in a sense, hardly less so.

Much information of historical value, some of it never before published, is scattered through the chapters of this book. Mr. Insull came to this country from London, his native city, in 1881, when he was twenty-one years old, to be private secretary to Thomas A. Edison. From that day to this he has been connected with electrical enterprises. His opportunities for gaining familiarity with all the various forms of electrical undertakings have been exceptional. His deep admiration for his old chief, Edison, has never abated, and some evidence of this loyalty is shown in nearly every chapter of the present volume. The future historian of that electrical development which was the marvel of the last quarter of the nineteenth

century and has become the necessity of the first quarter of the twentieth will surely find much that is illuminating in the following pages.

Originality and boldness are found in these addresses, but perhaps the dominant note is that of enthusiasm. The author is always sounding the charge, never the retreat; the papers are intensely alive, vibrant with the joy of achievement. "It is a very great pleasure to me to look back over the last thirty years," says the speaker in "Thirty Years of Electrical Development." This sturdy note of optimism is, or at least has been, characteristic of the industry as a whole. And the speeches are not without vivacity, frankness, the vivid touch. There is dramatic interest, surely, in the colloquy with the public-service commissioner in the Briarcliff speech on "The Larger Aspects of Making and Selling Electrical Energy." Nor is the element of humor neglected, as may be seen by the story in the Brooklyn address of the sleepy young chap of the early eighties watching the galvanometer at night during cable-testing on the street and being wakened by the nightstick of a friendly policeman when the "boss" came around. In the same chapter — that on "Stepping Stones of Central-Station Development through Three Decades"— there is an anecdote of Edison's rough-and-ready method of testing his three-wire-distribution idea that is of real human interest. Other stories and touches of byplay add variety to the pages, while in some passages intensity and earnestness may fairly be said to attain the dignity of eloquence.

Young men engaged in central-station work will find many words of encouragement in these addresses. The advice given is not altogether of the hackneyed sort. It gives the impression of sincerity and good feeling. Thus, addressing the employees of his own company ("A Quarter-Century Central-Station Anniversary Celebration in Chicago"), the speaker said: "There is one thing, in my twenty years of managing this business, that I am more proud of than anything else, and that is that I have been able to develop it with the assistance of the brains within the business." The genuine, sympathetic touch

here is unmistakable. And the message of hope is not given merely to build up one organization, for, farther on, we are told that "There isn't any reason why this Mississippi Valley, the richest part of the United States in productive ability, should not obtain the greater part of its men for the management of the great energy-producing companies that must be established throughout the Valley in the next fifty years from the boys who are now entering the service of the Commonwealth Edison Company."

One thing to be borne in mind in considering these speeches is that they were nearly all extemporaneous. They are not, as a rule, the carefully worded productions of secluded care, but the talks of a busy man of affairs, founded, of course, on study and experience, but depending for the immediate spoken word on the mental resources of a man on his feet and facing an audience. In many cases the speaker based his remarks on diagrams, curves or tables, prepared under his direction by assistants and exhibited to the assemblage. Responding to numerous requests for addresses from different organizations and from different cities, Mr. Insull spoke on the same general subjects on a number of occasions. To avoid duplication the editor has condensed some of the addresses where the repetition was obvious. But where, as was the case in a few instances, new matter was interwoven with what had been given, in substance, before, the plan has been to retain the whole rather than to reject it or to attempt to "unscramble" the new from the old. Nevertheless, the amount of duplication in the present volume is not great.

Perhaps a few words about the terminology of the electrical art may be permitted. During the period covered by these addresses there has been improvement in the manner of speaking and writing about electrical things. Thus, "electric current" has been restored to its proper scientific meaning, being now rarely used to designate "electrical energy," of which it is only one component. With more careful study we have come to use the words "force," "power" and "energy" with greater precision in electrical work. We differentiate more clearly at the

present time between "transmit" and "distribute." We are more apt to speak of "generator" than "dynamo" (although there seems to be little reason for this change, for "dynamo-electric machine" has a respectable lineage), and of "generating station" rather than "power house." The words "transformer" and "converter," once synonymous, designate radically different types of apparatus today, and "storage battery" has prevailed over "accumulator," once the more usual appellation. "Power factor" and "load factor" have been more clearly defined, and "diversity factor" has come into being with the development of the art. But there is still some confusion in the nomenclature, as, to take a familiar example, in the use of the qualifying words "electric" and "electrical." Apparently, the tendency is to assign to the former the status of a specific qualitative, as in "electric motor" and "electric railway," and to the latter that of a general qualitative, as in "electrical engineering" and "electrical phenomena." However, this distinction is not always observed. Those who are curious in such matters may notice, possibly, some discrepancy in the use of electrical terms in the earlier and later addresses presented in this work. The editor has felt free to alter phraseology in the interest of clearness, but not when such re-phrasing would replace the idiom of other days in such a manner as to obliterate racy characteristics of value.

Forty speeches and papers are given in this volume, following some preliminary matter relating to the early days of central-station history. The date of the first one is September 14, 1897, and of the last April 20, 1914. Over half were delivered in Chicago, nine in or very near New York, and the remainder in other places in the United States. The list does not include all of Mr. Insull's addresses, and several have been delivered since the last of those printed here. It will be noticed that after one address in 1897 and two in 1898 there was none for nearly ten years. It was in this period, it may be conceived, that the larger aspects of the business of supplying electrical energy were shaping themselves in the mind of the originator of these contributions to the development of the industry. It

was a learning period — a period of awakening. The papers show growth, expansion, broadening; and yet the very earliest is strikingly modern when re-read today. But, after all, this first essay goes back only eighteen years, while the central-station industry is thirty-three years old. The development of the industry, therefore, would seem to be logical and to rest on foundations broad and secure.

The editor desires to express his cordial thanks, for encouragement and assistance, to his friends, Mr. W. D. Weaver, of Charlottesville, Virginia, and Messrs. Edward Caldwell and T. Commerford Martin, of New York. Finally, he wishes to avow responsibility for all statements, whether of fact or comment, appearing in the notes inserted in the text.

William Eugene Keily.

Chicago, March, 1915.

EARLY WORK WITH EDISON

As has been noted on preceding pages, Mr. Insull obtained his start in the electrical industry as secretarial assistant and man of affairs for Thomas A. Edison. He conceived a warm friendship and a deep admiration for the famous inventor. Some expression to these sentiments is given, often in Mr. Insull's own language, in the biography "Edison — His Life and Inventions," written by Messrs. Frank Lewis Dyer and Thomas Commerford Martin, and published and copyrighted in 1910 by Harper & Brothers. By permission, the extracts which make up this chapter are reprinted from this work, to which the citations refer.

When the Telephone Was a Curiosity

Mr. Samuel Insull, who afterward became private secretary to Mr. Edison, and a leader in the development of American electrical manufacturing and the central-station art, was also in close touch with the London situation thus depicted,[1] being at the time private secretary to Colonel Gouraud, and acting for the first half-hour as the amateur telephone operator in the first experimental exchange erected in Europe. He took notes of an early meeting where the affairs of the company were discussed by leading men like Sir John Lubbock (Lord Avebury) and the Right Hon. E. P. Bouverie (then a cabinet minister), none of whom could see in the telephone much more than an auxiliary for getting out promptly in the next morning's papers the midnight debates in Parliament. "I remember another incident," says Mr. Insull. "It was at some celebration of one

1. Vol. I, chap. ix, page 192. The "London situation" grew out of the introduction of Edison's telephone in England in or about the year 1879.

of the royal societies at the Burlington House, Piccadilly. We had a telephone line running across the roofs to the basement of the building. I think it was to Tyndall's laboratory in Burlington Street. As the ladies and gentlemen came through, they naturally wanted to look at the great curiosity, the loud-speaking telephone; in fact, any telephone was a curiosity then. Mr. and Mrs. Gladstone came through. I was handling the telephone at the Burlington House end. Mrs. Gladstone asked the man over the telephone whether he knew if a man or woman was speaking; and the reply came in quite loud tones that it was a man!"

Looking After the Pay-Rolls

In addition[1] there must be included Mr. Samuel Insull, whose activities for many years as private secretary and financial manager were devoted solely to Mr. Edison's interests, with Menlo Park as a center and main source of anxiety as to pay-rolls and other constantly recurring obligations.

Young Insull Passes under the Spell of Edison at Their First Interview

These preparations[2] overlap the reinforcement of the staff with some notable additions, chief among them being Mr. Samuel Insull, whose interesting narrative of events fits admirably into the story at this stage, and gives a vivid idea of the intense activity and excitement with which the whole atmosphere around Edison was then surcharged: "I first met Edison on March 1, 1881.[3] I arrived in New York on the *City of Chester* about five or six in the evening and went direct

1. Vol. I, chap. xii, page 274. This refers to the latter half of the Menlo Park period of 1876–1886.

2. Vol. I, chap. xiv, page 328. The preparations were for the Paris Exposition of 1881.

3. A recent examination of a letter written by Mr. Insull to his mother at the time shows that this date should be February 28, 1881, one day earlier than the date of the text. It follows that the "March 2d" of page xxviii of this book should be "March 1st."

to 65 Fifth Avenue. I had come over to act as Edison's private secretary, the position having been obtained for me through the good offices of Mr. E. H. Johnson, whom I had known in London, and who wrote to Mr. U. H. Painter, of Washington, about me in the fall of 1880. Mr. Painter sent the letter on to Mr. Batchelor, who turned it over to Edison. Johnson returned to America late in the fall of 1880, and in January, 1881, cabled to me to come to this country. At the time he cabled for me Edison was still at Menlo Park, but when I arrived in New York the famous offices of the Edison Electric Light Company had been opened at 65 Fifth Avenue, and Edison had moved into New York with the idea of assisting in the exploitation of the company's business.

"I was taken by Johnson direct from the Inman steamship pier to 65 Fifth Avenue, and met Edison for the first time. There were three rooms on the ground floor at that time. The front one was used as a kind of reception-room; the room immediately behind it was used as the office of the president of the Edison Electric Light Company, Major S. B. Eaton. The rear room, which was directly back of the front entrance hall, was Edison's office, and there I first saw him. There was very little in the room except a couple of walnut roller-top desks, which were very generally used in American offices at that time. Edison received me with great cordiality. I think he was possibly disappointed at my being so young a man; I had only just turned twenty-one, and had a very boyish appearance. The picture of Edison is as vivid to me now as if the incident occurred yesterday, although it is now [1910] more than twenty-nine years since that first meeting. I had been connected with Edison's affairs in England as private secretary to his London agent for about two years, and had been taught by Johnson to look on Edison as the greatest electrical inventor of the day—a view of him, by the way, which has been greatly strengthened as the years have rolled by. Owing to this, and to the fact that I felt highly flattered at the appointment as his private secretary, I was naturally prepared to accept him as a hero.

"With my strict English ideas as to the class of clothes to be worn by a prominent man, there was nothing in Edison's dress to impress me. He wore a rather seedy black diagonal Prince Albert coat and waistcoat, with trousers of a dark material, and a white silk handkerchief around his neck, tied in a careless knot falling over the stiff bosom of a white shirt somewhat the worse for wear. He had a large 'wideawake' hat of the sombrero pattern then generally used in this country, and a rough, brown overcoat, cut somewhat similarly to his Prince Albert coat. His hair was worn quite long, and hanging carelessly over his fine forehead. His face was at that time, as it is now, clean shaven. He was full in face and figure, although by no means as stout as he has grown in recent years. What struck me above everything else was the wonderful intelligence and magnetism of his expression, and the extreme brightness of his eyes. He was far more modest than in my youthful picture of him. I had expected to find a man of distinction. His appearance, as a whole, was not what you would call 'slovenly'; it is best expressed by the word 'careless.'"

Mr. Insull supplements this pen-picture by another, bearing upon the hustle and bustle of the moment: "After a short conversation Johnson hurried me off to meet his family, and later in the evening, about eight o'clock, he and I returned to Edison's office; and I found myself launched without further ceremony into Edison's business affairs. Johnson had already explained to me that he was sailing the next morning, March 2d, on the S.S. *Arizona* and that Mr. Edison wanted to spend the evening discussing matters in connection with his European affairs. It was assumed, inasmuch as I had just arrived from London, that I would be able to give more or less information on this subject. As Johnson was to sail the next morning at five o'clock, Edison explained that it would be necessary for him to have an understanding of European matters. Edison started out by drawing from his desk a check-book and stating how much money he had in the bank; and he wanted to know what European telephone securities were most salable, as he

wished to raise the necessary funds to put on their feet the incandescent-lamp factory, the electric-tube works, and the necessary shops to build dynamos. All through the interview I was tremendously impressed with Edison's wonderful resourcefulness and grasp, and his immediate appreciation of any suggestion of consequence bearing on the subject under discussion.

"He spoke with very great enthusiasm of the work before him—namely, the development of his electric-lighting system; and his one idea seemed to be to raise all the money he could with the object of pouring it into the manufacturing side of the lighting business. I remember how extraordinarily I was impressed with him on this account, as I had just come from a circle of people in London who not only questioned the possibility of the success of Edison's invention, but often expressed doubt as to whether the work he had done could be called an invention at all. After discussing affairs with Johnson—who was receiving his final instructions from Edison—far into the night, and going down to the steamer to see Johnson aboard, I finished my first night's business with Edison somewhere between four and five in the morning, feeling thoroughly imbued with the idea that I had met one of the great master minds of the world. You must allow for my youthful enthusiasm, but you must also bear in mind Edison's peculiar gift of magnetism, which has enabled him during his career to attach so many men to him. I fell a victim to the spell at the first interview."

What was Expected of Edison's Private Secretary

We are indebted[1] to Mr. Insull for a graphic sketch of Edison at this period, and of the conditions under which work was done and progress was made: "I do not think I had any understanding with Edison when I first went with him as to my duties. I did whatever he told me, and looked after all kinds of affairs, from buying his clothes to financing his business.

1. Vol. I, chap. xv, page 368. The period is that of 1881 and immediately succeeding years.

I used to open the correspondence and answer it all, sometimes signing Edison's name with my initial, and sometimes signing my own name. If the latter course was pursued, and I was addressing a stranger, I would sign as Edison's private secretary. I held his power of attorney, and signed his checks. It was seldom that Edison signed a letter or check at this time. If he wanted personally to send a communication to anybody, if it was one of his close associates, it would probably be a pencil memorandum, signed 'Edison.' I was a shorthand writer, but seldom took down from Edison's dictation, unless it was on some technical subject that I did not understand. I would go over the correspondence with Edison, sometimes making a marginal note in shorthand, and sometimes Edison would make his own notes on letters, and I would be expected to clean up the correspondence with Edison's laconic comments as a guide as to the character of answer to make. It was a very common thing for Edison to write the words 'Yes' or 'No,' and this would be all I had on which to base my answer. Edison marginalized documents extensively. He had a wonderful ability in pointing out the weak points of an agreement or a balance-sheet, all the while protesting he was no lawyer or accountant; and his views were expressed in very few words, but in a characteristic and emphatic manner.

Engineering and Manufacturing Work

"The first few months I was with Edison he spent most of the time in the office at 65 Fifth Avenue. Then there was a great deal of trouble with the life of the lamps there, and he disappeared from the office and spent his time largely at Menlo Park. At another time there was a great deal of trouble with some of the details of construction of the dynamos, and Edison spent a lot of time at Goerck Street, which had been rapidly equipped with the idea of turning out bipolar dynamo-electric machines, direct-connected to the engine, the first of which went to Paris and London, while the next were installed in the old Pearl Street station of the Edison Electric Illuminating

Company of New York, just south of Fulton Street, on the west side of the street. Edison devoted a great deal of his time to the engineering work in connection with the laying out of the first incandescent electric-lighting system in New York. Apparently at that time — between the end of 1881 and spring of 1882 — the most serious work was the manufacture and installation of underground conductors in this territory. These conductors were manufactured by the Electric Tube Company, which Edison controlled in a shop at 65 Washington Street, run by John Kruesi. Half-round copper conductors were used, kept in place relatively to each other and in the tube, first of all by a heavy piece of cardboard and later on by a rope; and then put in a twenty-foot iron pipe; and a combination of asphaltum and linseed oil was forced into the pipe for the insulation. I remember as a coincidence that the building was only twenty feet wide. These lengths of conductors were twenty feet six inches long, as the half-round coppers extended three inches beyond the drag-ends of the lengths of pipe; and in one of the operations we used to take the length of tubing out of the window in order to turn it around. I was elected secretary of the Electric Tube Company, and was expected to look after its finance; and it was in this position that my long intimacy with John Kruesi started."

The Sale of the Schenectady Works

"At these new works[1] our orders were far in excess of our capital to handle the business, and both Mr. Insull and I were afraid we might get in trouble for lack of money. Mr. Insull was then my business manager, running the whole thing; and, therefore, when Mr. Henry Villard and his syndicate offered to buy us out, we concluded it was better to be sure than be sorry; so we sold out for a large sum."

1. Vol. I, chap. xv, page 382. The quotation in this paragraph is from Edison. The "new works" are those at Schenectady, N. Y. The formation of the Edison General Electric Company followed the sale mentioned.

First Three-Wire Station and the "Destruction Department"

"The next day[1] Mr. Edison, Mr. Insull and the chief engineer of the construction department appeared on the scene and wanted to know what had happened. They found an engine somewhat loose in the bearings, and there followed remarks which would not look well in print. Andrews skipped from under; he obeyed orders; I did not. But the plant ran, and it was the first three-wire station in this country."

Seen from yet another angle, the worries of this early work were not merely those of the men on the "firing line." Mr. Insull, in speaking of this period, says: "When it was found difficult to push the central-station business owing to the lack of confidence in its financial success, Edison decided to go into the business of promoting and constructing central-station plants, and he formed what was known as the Thomas A. Edison Construction Department, which he put me in charge of. The organization was crude, the steam-engineering talent poor, and owing to the impossibility of getting any considerable capital subscribed, the plants were put in as cheaply as possible. I believe that this construction department was unkindly named the 'Destruction Department.' It served its purpose; never made any money; and I had the unpleasant task of presiding at its obsequies."

Edison's "System"—and a Tribute

Mr. Samuel Insull describes[2] the business methods which prevailed throughout the earlier Menlo Park days of "storm and stress," and the curious conditions with which he had to deal as private secretary: "I never attempted to systematize Edison's business life. Edison's whole method of work would upset the system of any office. He was just as likely to be at

1. Vol. I, chap. xvii, page 428. The speaker in this instance is Mr. Frank J. Sprague, and he is describing the building of the Sunbury (Pa.) generating station in 1883.

2. Vol. I, chap. xii, page 278.

work in his laboratory at midnight as midday. He cared not for the hours of the day or the days of the week. If he was exhausted he might more likely be asleep in the middle of the day than in the middle of the night, as most of his work in the way of inventions was done at night. I used to run his office on as close business methods as my experience admitted; and I would get at him whenever it suited his convenience. Sometimes he would not go over his mail for days at a time; but other times he would go regularly to his office in the morning. At other times my engagements used to be with him to go over his business affairs at Menlo Park at night, if I was occupied in New York during the day. In fact, as a matter of convenience I used more often to get at him at night, as it left my days free to transact his affairs, and enabled me, probably at a midnight luncheon, to get a few minutes of his time to look over his correspondence and get his directions as to what I should do in some particular negotiation or matter of finance. While it was a matter of suiting Edison's convenience as to when I should transact business with him, it also suited my own ideas, as it enabled me after getting through my business with him to enjoy the privilege of watching him at his work, and to learn something about the technical side of matters. Whatever knowledge I may have of the electric-light-and-power industry I feel I owe to the tuition of Edison. He was about the most willing tutor, and I must confess that he had to be a patient one."

AN INTIMATE PERSONAL OPINION OF THE PROSPECTS OF THE ELECTRIC LIGHT IN 1881 FROM EDISON'S YOUTHFUL PRIVATE SECRETARY

Two months after landing on the soil of the United States for the first time, and becoming private secretary to Mr. Edison, Mr. Insull wrote a letter to a friend in England which is worth preservation for its historical value as well as a real "human-interest" document. This letter to Mr. J. E. Kingsbury,[1] which forms the subject of this chapter, gives a vivid, first-hand description of the high hopes, the high-pressure planning, the days and nights of hard but enthusiastic work under the direction of the master mind of the great inventor at the time when incandescent electric lighting and central-station electric service were really in their infancy. A youth of twenty-one was the writer of the letter, and the enthusiasm of the boyish hero-worshiper is very evident; and yet, at the first flush of manhood, to be a trusted assistant among those who were bringing into being a great but dimly foreseen industry was enough to stir the pulses of a man more sluggish than Mr. Kingsbury's correspondent.

1. Mr. Kingsbury and Mr. Insull, both Englishmen by birth, were associated with Colonel George E. Gouraud, at that time Edison's agent in London, from early in 1879 until early in 1881, when Mr. Insull came to the United States. As mentioned in the preceding chapter, the youthful Insull was Colonel Gouraud's private secretary. His friend Kingsbury handled the publicity and advertising affairs of the office, being also associated with an uncle who was in the advertising-agency business. Later Mr. Kingsbury formed a connection with the English house of the Western Electric Company, and for many years he was at the head of the London office, being still (1915) a director of the Western Electric Company, Limited. It is rather interesting to note that one of the pair became the London representative of Chicago's greatest electrical manufacturing concern and the other the head of the great electric-service company of Chicago.

The letter was written in long-hand on twelve sheets of paper. Two pages, the first and the last, are reproduced in reduced facsimile. Practically complete, the missive reads as follows:

LABORATORY OF
THOMAS A. EDISON
MENLO PARK, N. J.

Sunday, 1st May, 1881.

My Dear Kingsbury:

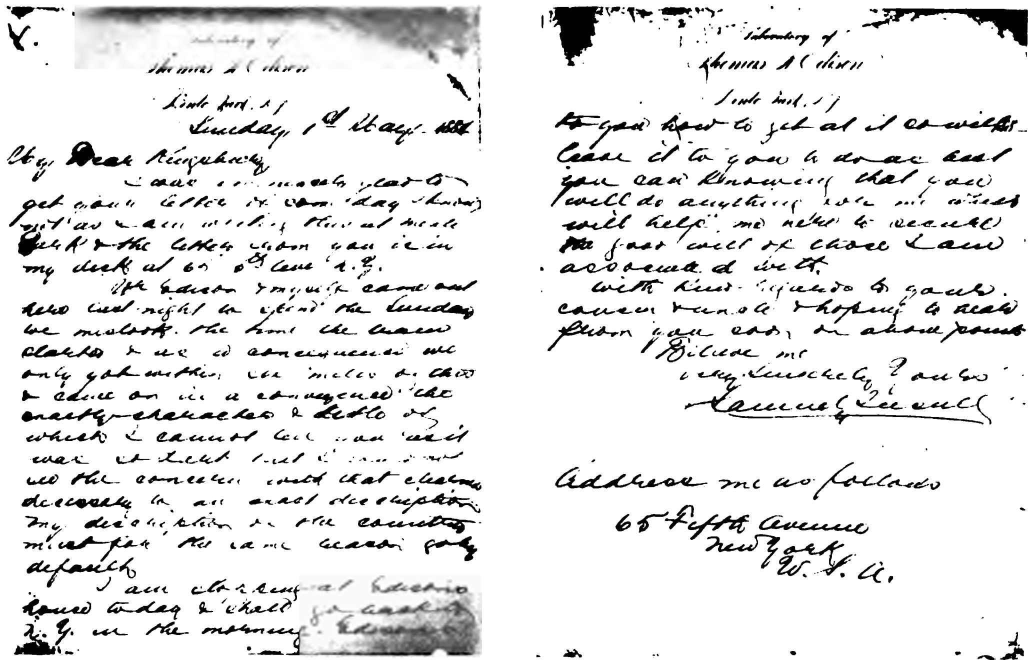
I was immensely glad to get your letter of some day I know not, as I am writing this at Menlo Park, and the letter from you is in my desk at 65 5th Ave., N. Y.

Mr. Edison and myself came out here last night to spend the Sunday. We mistook the time the train started and as a consequence we only got within six miles of this [place] and came on in a conveyance the exact character and title of which I cannot tell you, as it was so dark that I could not see the concern with that clearness necessary to an exact description. My description of the country must for the same reason go by default.

I am stopping at Edison's house today and shall go back to N. Y. in the morning. Edison's people are A No. 1 and make it very pleasant for me. This morning Mrs. Edison placed a fine pair of grey ponies at my disposal, and I flew along the rough Jersey road with a comfort only to be attained with the assistance of American ponies attached to the light vehicles which abound here.

Your letter was most acceptable. I was wondering whether you had forgotten me altogether, and I am glad to see that you have not. Your assumption that I get all the news is quite misplaced, and your letter gave me information for which I was thirsting. Just go into a little more detail the next time you write me.

A few days after I came here I called on the people controlling the electric pen here (The Western Electric Mfg. Co.)



Laboratory of Thomas A. Edison
Menlo Park, N.J.
Sunday, 1st May. 1881

My Dear Kingsbury
I was exceedingly glad to get your letter of yesterday showing that you are [illegible] [illegible] the letter [illegible] you is in my desk at 65 5th Ave N.Y.
Mr Edison & myself came out here last night to spend the Sunday [illegible] the train [illegible] & we in consequence [illegible] only got within [illegible] miles of this & came on in a conveyance the [illegible] character & details of which I cannot tell you [illegible] the [illegible] description my description of the country [illegible] for the same reason [illegible] default
I am stopping at Edison's house today & shall [illegible] N.Y. in the morning [illegible]

Laboratory of Thomas A. Edison
Menlo Park, N.J.
to you how to get at it & will leave it to you to do as best you can knowing that you will do anything [illegible] which will help me [illegible] the [illegible] of those I am associated with.
With kind regards to your cousin & uncle & hoping to hear from you soon on above points
Believe me
very sincerely yours
Samuel Insull

Address me as follows
65 Fifth Avenue
New York
U.S.A.

Reduced Facsimiles of the First Page and the Last Page of a Letter to Mr. Kingsbury in 1881

and yet the simplest thing imaginable. The district which he will light up first in New York has about 15,650 lights in the various buildings in the district and a great deal of power varying in amounts. He is getting contracts just as fast as his canvassers apply for them, and we have large gangs of men wiring the houses in anticipation of the time when we can lay our mains, erect our dynamo machinery and light up. I suppose this district will be all lighted up in from three to four months, and then you [will] see what you will see. You will witness the amazing sight of those English scientists eating that unpalatable crow of which Johnson used to speak in his letters to me when I was in the old country.

Menlo Park is practically abandoned. All experiments are finished; all speculation on the probable results are dismissed; and Edison thinks, and so does everyone else who has looked into the matter, that success is assured. Of course time alone can prove this. As for myself, I am not competent to judge but I can use my eyes, can see the success with which the houses, fields, roads and Depot have been illuminated here, and I can see nothing to disprove the assertions. His lamps last about 400 hours; at all events that is the estimate by a time test, i.e., by running them at about four times their ordinary candle power until the carbons break; but this estimate is every day falsified, and experience points to the conclusion that the life of his lamps will be *much longer* than the estimate. As for rivals, Edison has but little fear, *in fact*, none from them. I have seen how Maxim's lamps go, and his utter want of a system by means of which alone can success be attained, and Swan we put in about the same category, but as he is a fellow countryman of mine, I will spare you the plain language used towards him.

To carry out the gigantic undertaking of fighting the gas companies we have much to do. A great difficulty is to get our machinery manufactured. This Mr. Edison will attend to himself. He personally has taken very large works for this purpose, where he will probably within the next six months have 1,500 men at work. The various parts of the machines will be contracted out, one firm making one part in large quan-

tities, another firm another part and so on. At Mr. Edison's works ("Edison Machine Works"), all these parts will be assembled and put together. Then there is the lamp factory, in which Mr. Edison owns almost all the interest, for manufacturing lamps and which is now turning out one thousand lamps a day, the Electric Tube Company (of which I am secretary and Mr. E. president) for manufacturing our street mains. So you can imagine what Mr. Edison has to do, as he is the mainspring and ruling spirit of everything. And you can imagine also what I have to do as his private secretary. We work every night till the small hours, and today (Sunday) is the first Sunday I have not been at the office; and even here we are at work, as between the intervals of writing this letter I am taking notes of a lot of data he wants before I go to bed tonight. I have got right in with Edison, sit in the same room with him, assist him in everything, and am his private secretary in every sense of the word. People say that he likes me very much; but time must be left to prove this. Johnson says my success is assured, and last, but not by any means the least, I am absolutely satisfied that I did the right thing in coming here.

Please find out for me and let me know at the earliest possible moment the exact price per 1,000 ft. at which gas is *sold by all* the various companies in London and also the price per ton at which the various kinds of *steam* and household coal can be purchased there in large quantities. Do me the very great favour of getting this out to me *at once* as I have promised to get it, as I dispute some figures furnished here.

[Two short paragraphs, relating principally to personal matters, are omitted here.]

With kind regards to your cousin and uncle and hoping to hear from you soon on above points, believe me

Very sincerely yours,

Samuel Insull.

Address me as follows

65 Fifth Avenue,

New York,

U. S. A.

ADDRESSES OF SAMUEL INSULL

PROBLEMS OF THE EDISON CENTRAL-STATION COMPANIES IN 1897[1]

THE DECISION of the members of the association at the last annual meeting to hold their eighteenth convention at Niagara Falls was naturally dictated by the world-wide interest in the work of generating and distributing electrical energy, using the famous Niagara River as the prime mover. In assembling at a spot where so much can be learned by those engaged in the electrical business, we are, as an association, paying the highest tribute that we can to the wonderful work of those who have had the courage, as capitalists and engineers, to design and build a plant which has given a great impetus to the economical production of electricity, not only by means of water as the prime mover, but by all other methods for the production of electrical energy. We cannot all have

1. It was in 1892 that Mr. Insull resigned the position of second vice-president of the General Electric Company (formed by the consolidation of the Edison General Electric Company and the Thomson-Houston Electric Company) and became president of the Chicago Edison Company. Barely four years later he was elected president of the Association of Edison Illuminating Companies, the membership of which, then as now, was made up of the electric-service companies of the larger cities of this country. A year afterward, on September 14, 1897, he delivered the presidential address before the Edison association which is reprinted here. The convention was held at Niagara Falls, N. Y., as shown by the text. This is perhaps the first of a long series of addresses before societies and associations, many of which are reproduced, in whole or in part, in this work. Mr. Insull was thirty-seven years of age at the time of its delivery. It is rather remarkable that so many problems later discerned to be of vital importance in electric service should be here apprehended so clearly. Concentration of production, electrical securities as investments, the use of larger generating units, the rate question, uniform accounting, and (with prophetic vision) the welcoming of new inventions, are some of the subjects presented in brief for discussion. Unlike nearly all of the later addresses, this one was written out in advance and read from manuscript.

the advantage of a large waterpower to assist in the economical production of our product right at our threshold; but in studying the methods employed here at Niagara Falls there is much information that we can take away with us which will lead us to concentrate our works at the most economical point of production in the various cities in which we live. Further, we can take advantage of the methods of distribution here employed to distribute our product to distant points, where we desire to use it, far more economically than we can produce it at those distant points themselves.

Why the Edison Association was Formed

Sometimes the question is asked by those engaged in the electric light and power business why the companies known as "Edison illuminating companies" or "Edison licensees" should find it necessary to combine themselves into an association. This question is best answered by the fact that the Edison illuminating companies all operate under practically the same form of contract with the company that controls the Edison patents, namely, the Edison Electric Light Company. In the main they purchase their goods, under contract, from the same licensed manufacturer of the patent-owning company, namely, the General Electric Company, and as there is but one Edison operating company in each particular city, the interests of these various companies are naturally mutual.

When I remind you that the various companies which we, either as officers or employees, have the honor of representing here, have invested in their business more than $105,000,000,[1] it will be readily appreciated that it must be greatly to the advantage of the various properties which we operate that we should meet from time to time to exchange ideas as to the proper conduct of our business, and that we should continue

1. Perhaps this amount would be ten times as great if stated at the present day. It is interesting to note that merely the electric-service companies of which Mr. Insull is the president at the present time (1915) have a capitalization much larger than the figure mentioned in the text for all the companies in the Edison association eighteen years ago.

an organization to watch over our interests in our dealings with the patent-owning and manufacturing side of the Edison business.

Experience of Investors

At what happily would appear to be the close of an unparalleled period of industrial depression, the various Edison illuminating companies have certainly much cause for mutual congratulation. Nothwithstanding this long period of paralysis of industrial enterprise, they have, with hardly an exception, been able to show good earning capacity and to pay to the holders of their securities a substantial return on their investment. This is partly owing to the inherent merit of our business, partly to the wise foresight of the illustrious inventor whose system this business is based on, and partly to the conservatism of the original projectors of the Edison lighting and power business, who insisted that the Edison illuminating companies should be established on a sound financial basis.

This experience during the depressed times will necessarily lead investors to the conclusion that the securities of the Edison illuminating companies are among the most desirable of local investments. If it is possible to earn substantial returns on capital invested during such periods of business disturbances as that which we have recently gone through, surely we can look forward to laying up a substantial surplus to provide against a "rainy day" during the times of prosperity, which all of us hope, and some of us think, we are now entering upon.

The use of large generating units in the larger stations for the production of electrical energy, begun but a few years ago, and the necessity of extending the field of our operations into distant portions of our territory, have forced upon many of us the desirability of employing more economical methods of transmission, with a view to the abandonment of small and expensive stations and the concentration of our production of electricity at the point of greatest economy. This matter was touched upon to a certain extent at the last convention. A number of our companies are now spending large sums of

money on these lines, and as a result of the importance that this subject has assumed it is but natural that a considerable portion of our time will be occupied in deliberating on this subject.

In connection with the matter of economical transmission, the subject of economical storage is naturally of importance, and we should, in the course of our proceedings, be able to obtain considerable information on the advantages of the use of the storage battery, in connection with the Edison system, from those who have had the courage of their opinions and have invested largely in storage-battery plants. I think we all concede the advantages to be obtained from the use of storage battery from the storage point of view only; but some of us are still in doubt as to our ability to save sufficient money by this plan to justify the large investment required.

The Rate Question

A subject of prime importance in connection with the economical production of our product is the basis upon which we shall sell it to our customers. It should be remembered that we are engaged in a public business, and that our companies have duties to perform to the public as well as money to earn for our security-holders. In fulfilling our obligations to the public the question of the basis of charging for our product is the all-important one. This is a matter which on previous occasions has received your earnest attention, and is one on which there will be undoubtedly earnest discussion on this occasion.

For several years past some of the larger illuminating companies, members of this association, notably those of Boston, New York and Chicago, have been in the habit of comparing the details of cost and selling price of their product, their accounts being kept on the same basis, as near as local conditions will permit. The information obtained, so far as my experience goes, has been of great advantage in enabling the companies in question to reduce their cost and in assisting them to an intelligent decision as to the policy to adopt towards

their customers. It seems to me that it would be advantageous to the members of this association if a uniform system of accounts were adopted and arrangements made to compare the results obtained by the various companies operating under similar conditions. In putting such a scheme into operation a number of difficulties would naturally have to be overcome, such as the differences in local conditions and the necessity of carefully guarding information of so confidential a character; but I would suggest the desirability of the association instructing the executive committee to take this matter up with a view to formulating a plan which might be tried experimentally.

Establishment of Lamp-Testing Bureau

The main business of your executive committee during the last year has been the negotiating with the General Electric Company of a contract and specifications with relation to the incandescent lamps used by the Edison licensees who are members of this association. As a result a lamp-testing bureau has been established at the lamp factory at Harrison, N. J., which bureau is under the control of this association and is operated for its account by Mr. Wilson S. Howell. A number of our members have taken advantage of the arrangement made, and we believe that considerable benefit will accrue to those who arrange to purchase their lamps under the contract in question. Great credit is due to the chairman and members of the executive committee for the results they have been able to achieve, and they are certainly deserving of our thanks for the time and money they have spent in this matter for our benefit. I think for the first time in the history of the electric-lighting business we are now able to obtain lamps made according to specifications agreed on, and the results must be an improvement in our service and a saving of money to our central-station companies. The details as to this matter will be carefully dealt with in reports by Mr. C. L. Edgar, chairman of the executive committee, and Mr. Wilson S. Howell, the testing officer in charge of the bureau at Harrison.

Relations of Operating and Manufacturing Companies

Relations of the Edison licensees with the Edison Electric Light Company and its licensed manufacturer, the General Electric Company, have been of the pleasantest character during the last year. This is probably owing to the fact that those operating the General Electric Company since the consolidation of the Thomson-Houston Company and the Edison Electric Company have had fuller opportunity, as time has gone by, to appreciate the importance of the Edison licensee business to the patent-owning and manufacturing interests. The matter of patents continues to be in far from a satisfactory condition, the licensees receiving very little protection in the enjoyment of the exclusive privileges under the Edison patents which they had every reason to look for in view of the large amount of royalty paid by them to the parent company. It is doubtful whether the Edison Electric Light Company or the General Electric Company can be held responsible for this state of affairs, as they have continued to spend very large sums of money in the prosecution of their patent rights in the courts.

It is to be regretted that many of the electrical manufacturing companies continue to foster opposition central-station plants, in territory already covered by good paying illuminating properties, with the result of seriously affecting the credit of the customers upon whom the manufacturers must rely for trade, if they desire to create a permanent manufacturing business. We have all of us suffered more or less from this policy of the manufacturing interests, and while in some cases there may possibly be a temporary advantage to one or another manufacturer, it is natural for us to wonder what permanent advantage can come to the manufacturing interests as a whole by the adoption of methods which would seem to have in view the ultimate destruction of the goose that lays the golden egg.

Value of Edison Distribution System

With the many changes that must of necessity take place in so new a business as the electric-light-and-power industry,

the question is often raised as to whether or not our plant is of a permanent character. A close examination of the Edison system must bring home to any one the fact that the wonderful inventive and engineering talent displayed by Mr. Edison in his early work has given us the advantage of a system that is of the utmost permanency. Our main investment, in the larger cities at least, is in our underground work, and if you will look over the records of the various companies using the Edison system, I think you will find that their underground work is as useful to them now as when it was laid, and it seems to me that there is no reason for us to fear that this condition will change in the future. We may have different methods of illumination; we may get a higher voltage lamp; we may find that the current of the future will not require as large a cross-section of copper as in the past; but I doubt if we will find that any method of distribution will be invented that will supplant that which we are using; and if such be the case, we should rather welcome than fear new inventions, feeling that in our particular cities we are the most desirable purchasers of any inventions which may lessen the cost of electrical energy to our customers.

When those of us who have been connected with this great industry from its early childhood recall the fact that scientists and inventors on both sides of the Atlantic persistently condemned the scheme originally laid out by Mr. Edison, we must, as central-station managers of today, feel that we owe a deep debt of gratitude to him for his courage in insisting that the only practicable method of distribution of electrical energy was by the use of a constant pressure and a varying current when everybody else was talking a constant current and a varying pressure. With every desire to pay tribute to the many brilliant men who have contributed to the success of the business of manufacturing and distributing electrical energy, we venture to contend that their work is all subordinate to that of the master mind who persisted in the early experimental days at Menlo Park in working on a multiple-arc system, without which (with the exception of the series arc light) no form of electric light or electrical energy could be commercially operated today.

THE DEVELOPMENT OF THE CENTRAL STATION[1]

WHEN requested a short time ago by the chief of the electrical department of this university to deliver a lecture on some subject connected with central-station work, I must confess to some misgivings in accepting the honor, remembering the hesitation that a commercial man invariably feels in discussing technical matters before those having had technical training. Then I remembered that even within my own time (and I think I can still lay claim to being a young man) very little was known of the general distribution of electrical energy from a central station. Further, when I recalled that so recently as the early eighties it was necessarily the rule for "guessing to be a substitute for mathematics" (to use the words of the great pioneer in central-station work), my misgivings began to disappear, and I felt encouraged to talk to you on the development of the central station from the point of view of my own experience in following this, the latest of the great industrial developments of the wonderful era in which we live.

In referring to the development of the central station, it would seem hardly necessary to go at length into the history of the business, the origin of which probably dates from the work of the early experimenters whose efforts were directed to the perfection of series arc lighting. While their work is entitled to the greatest possible praise, it should be remembered that the theory on which they worked, namely, constant current

1. A lecture delivered on May 17, 1898, before the Electrical Engineering Department of Purdue University, Lafayette, Ind. This address is not only of historical value, but vigorous and far-seeing in treating of the cost of money, load factor, the tendency of rates to decrease and other modern studies. It was written in advance and read from manuscript.

and varying potential, is a theory foredoomed to failure, when applied to the development of a system of general distribution for light and power purposes, the first essential of which is the necessity for a constant potential, the quantity of current varying in accordance with the demands made by those desiring to use the energy, whether for light or power purposes. Nor does it seem to me a matter very pertinent to the present occasion to trace the rival claims as to priority of invention of the early experimenters on incandescent lamps. Which of them was the first to produce a lamp that could be brought to a state of incandescence by means of the electric current is hardly within the scope of our inquiry. Probably all of them, groping in the dark (now and then illumined by the flashes of light emitted from their experimental glow lamps), contributed in a more or less degree to the perfection of the incandescent lamp as now in everyday use. But so far as their contributing much that is substantial, in the development of a system of central-station distribution, it is probable that, up to the year 1880, there was but one man who realized that in solving the great problem of electrical distribution the perfection of a filament of high resistance, which, placed in a hermetically sealed glass globe from which the air had been exhausted, and connected in multiple arc across an electric circuit, was the first necessity to the distribution of electrical energy in our cities from a central-station system.

The High-Resistance Incandescent Lamp

In Mr. Edison's application for a United States patent on a system of electrical distribution, filed at Washington on February 5, 1880, he says:

> The translating devices for each house may be either for light or power, or both. For light, the electric lamp, consisting of an incandescing material hermetically sealed in glass (shown in other applications made by me) is preferred. This lamp is made of a high resistance in comparison with that of any electric lamps which, to my knowledge, have been proposed. In lights heretofore proposed the endeavor seems to have been to lessen the resistance of the carbon, none having been suggested of higher resistance than, say, 10 ohms; but I have discovered that a very much higher resistance, say 100 ohms, must be used, in order that a number may be economically and successfully used in a system.

The question of the high resistance of the translating device was the first stepping-stone to success. Everybody prior to Edison had aimed at getting a low-resistance lamp, I presume on the theory that the less the resistance of one the less the resistance of the whole series. Edison struck out on new lines. A high-resistance lamp was naturally followed by a multiple-arc system.

In writing of the necessity of a high-resistance lamp, the applicant for the patent had in mind that a system of electrical distribution could be used at the same time not only for lighting, but for power purposes, if the motors were properly constructed, and this is shown by the next paragraph in his application, which states:

> The motors should be so constructed that each, with a constant flow or pressure of current, will give the exact power required. This requires that each motor should be wound with finer or coarser wire, and into more or less convolutions, which determine the maximum effect of the motor.

If you will search the files of the daily and technical journals, and the proceedings of various scientific societies on both sides of the Atlantic from the summer of 1878 up to and including the year 1882, you will find that the great obstacles in the way of an economical system of central-station distribution were the difficulties of producing a lamp that would last, one requiring only a minimum of current, and a system of electrical distribution requiring a minimum of capital, so as to enable electricity to compete with then existing methods of illumination and power. Professor Henry Morton, on December 28, 1879, says in the *New York Times:*

> The first difficulty of all is the production of a lamp which shall be thoroughly reliable, and neither complicated nor expensive. All attempts up to the present lamp in this direction are acknowledged to be failures, and as I have pointed out, there does not seem to be any novelty such as would authorize us to hope for better success than the present one. The next difficulty is the economical production of small lights by electricity. This is what is commonly meant by the phrase, "dividing the electric light." Up to the present time, and including Mr. Edison's latest experiments, it appears that this involves an immense loss of efficiency.
>
> Next comes the difficulty of distributing on any large scale the immense electric current which would be needed, and to provide for their equal action at different points under varying conditions of the number of lights used.

"Subdividing the Electric Light"

Again Mr. Conrad Cooke, giving evidence before the British Parliamentary Commission in 1879, in answer to the question: "Supposing that the occupier of one house wished to put out his lights, how would this be effected?" replied:

> In that case, if you throw out a lamp or throw out a house, you must throw into the circuit a resistance exactly equal to what you cut out. If you do not do that, you will affect every lamp in the series and the machine as well. If you put out your lights by breaking the circuit, you put out every light in the series.

In answer to another question at the same parliamentary inquiry, Mr. Cooke said (referring to Dr. William Siemens, who had been named in the question):

> His nephew told me himself that he had seen, I think, over 200 lamps on one of Edison's circuits.

And Mr. Cooke added:

> I must say I should like to see it myself, and that is all I can say.

It is quite evident from this that Conrad Cooke, very well known in England as a prolific writer on the subject of electrical experiments, had in mind, in 1879, nothing better than the series system, that is, a number of incandescent lamps run precisely the same as arc lamps, or, to put it another way, his idea of the electric lighting system was a varying potential and a constant current, which could never be run on a large scale successfully. Sir William Thomson (Lord Kelvin), referring to the same parliamentary inquiry of 1879, says:

> I had not myself, at that time, any idea leading toward the practical realization of any such distribution of conductors and placing the lights as outlined in the Edison mulitple arc and feeder system.

Evidently Mr. Swan, the English inventor, had no idea of the feeder system as late as October, 1880, as in a lecture before the Literary and Philosophical Society of Newcastle, England, at that time, he said:

> The only way of avoiding this waste of energy, without abandoning the idea of small units of light, would be either to employ enormously thick conductors, or have a very limited area supplied from one source.

Mr. Swan was referring to Mr. Edison's plain multiple-arc system, as set forth in his application of February, 1880. The last eight words of this quotation prove that Mr. Swan did not then know of Mr. Edison's feeder system, application for patent on which was made on the 9th of August, 1880, and was patented in England on the 24th of September of the same year. It would seem that even in 1882 Mr. Swan, who himself at that time must have been informed as to Mr. Edison's invention of the feeder system, could not have appreciated the possibilities of such a system, as, in a paper communicated to the British Association at Southampton in August of that year, he said:

> The only escape from that limitation (extent of distribution) lay in having secondary batteries at stations or in houses, and in these batteries being connected in series, and fed by currents of higher tension, the principle still holding of multiple arc, not from the central station, but from the subsidiary ones from which the batteries are charged. Once imagine the possibility of these secondary batteries being kept at a perfectly constant condition of charge by some automatic arrangement, and we might look to that as a means of escaping from the difficulties of wide distribution.

Early Discussion in England

Again we find that Dr. Siemens, before the Society of Arts in London, on the 15th of November, 1882, declared that

> It would be possible to establish electrical mains in the shape of copper rods of great thickness with branches diverging from them in all directions, though he was himself decidedly averse to such a plan. He said he would limit the area of the densely populated district to one quarter of a square mile, notwithstanding other individuals of high standing in electrical circles held that areas of from one to four square miles could be worked to advantage.

Dr. Siemens went on to say:

> In considering the proper size of conductors, two principal factors have to be taken into account: First, the charge for interest and depreciation on the original cost of a unit length of the conductor, and secondly, the cost of the electrical energy lost through the resistance of a unit of length. The sum of these two, which may be regarded as the cost of the conveyance of electricity, is clearly least, as Sir William Thomson pointed out some time ago, when the two components are equal. This, then, is the principle on which the size of a conductor should be determined.

Sir William Thomson, commenting on Dr. Siemens' remarks of November 15, 1882, before a commission taking evidence with relation to the Edison feeder patent, said:

There is not a word here of the necessity to secure against too great drop of electric potential between the dynamo and the lamps, or too great differences of drop between the different lamps of the system, and the narrow limitation of the area insisted upon shows that Dr. Siemens had no idea of Edison's solution of the problem, and thought only of overcoming the difficulty by enormously massive copper conductors with branches diverging from them to the points of consumption. From his earliest commencement as an inventor and engineer, Siemens had been occupied with water and gas. His first invention was a water-meter, and it is not probable that anyone in the years 1879–80 knew better than he did of the difficulties met with in the distribution of water and gas and of the methods which had been practically used or proposed for overcoming them.

Again referring to this subject, the same authority said:

About that time, or a little later, one of our first electrical engineers, Mr. Crompton, who has, in fact, been the first to introduce successfully and on a large scale, lighting from a central station in London, told me that he was obliged to use larger copper conductors than would be required merely in accordance with my principle for economy, in order to avoid so great a drop in potential as would be inconsistent with the good working of the lamps. At that time he had no idea of the feeder system, which he has since adopted with marked success in the Kensington-Knightsbridge electric lighting. Siemens' solution was not augmenting the size of the conductors above that calculated from the economic law, but to limit the size of the station supplied. Neither this nor the solution first proposed by Crompton is satisfactory in respect to the practical demands for the electric lighting of towns. Edison's feeder system is now universally admitted to be satisfactory to a very remarkable degree. I am asked why did not some one else invent it. The only answer to this, the last part of the question, that I can think of, is that no one else was Edison.

Well do I remember Sir William Thomson's visit to the Pearl Street station in New York, in 1884, when he saw the Edison feeder system first in operation, and the great interest that he exhibited in studying it, and his admiration for the work accomplished by Mr. Edison.

Value of Edison's Work

I have thought it necessary to quote at length some of the leading English authorities on electrical matters, as I thought it would be better, in asserting for an American the conception of the true basis of electrical distribution for light and power purposes, to give you the opinion and views on the matter of distribution of our "kin beyond the sea" rather than to quote the views of American scientists who might possibly be considered more partial to the work of their own countryman.

It is often said that the principles of constant-potential multiple-arc distribution and the use of feeders to maintain an equal and economical distribution of pressure are self-evident propositions, following the lines of gas and water distribution; but when you have such high authorities as Conrad Cooke in 1879 failing to recognize any of these necessities, of Mr. Swan in 1880 only recognizing the principles of multiple arc, and in 1882 failing to recognize the importance and far-reaching results of the feeder system, and Dr. Siemens as late as November, 1882, two months after a central station was in operation in New York city, adopting almost the same views as Mr. Swan, you can not wonder at Lord Kelvin answering the question as to why some one else did not invent the feeder system by saying, "The only answer to this, that I can think of, is that no one else was Edison."

It would seem to me, with such authorities, that it is not unreasonable to contend that the development of the central station and distribution system connected therewith dates from Mr. Edison's work at Menlo Park. Mr. Edison had been engaged during the early seventies, first as a telegraph operator in the Western Union service, and later working on the gold indicators in the gold room in New Street, New York, during the stirring period of speculation in the precious metal which culminated on Black Friday in 1873. Professor C. C. Law, now connected with the University of Missouri, had, I believe, charge of the indicating instruments, and it is a matter of some interest to record the fact that the first work Mr. Edison did of an inventive character which yielded him a financial return was in connection with and while he was at work on the gold indicators in question. Subsequently he was employed in the interest of what is now the Western Union Telegraph Company in improving the now universally used stock ticker. This was followed by brilliant and successful work in connection with the duplex and quadruplex and automatic systems of telegraphy, and the invention of the phonograph and that part of the telephone now generally used for transmitting purposes and known as the carbon transmitter. His attention to the possibilities of

what is popularly called the subdivision of the electric light was probably the result of a visit he paid to Mr. William Wallace at Ansonia in the fall of 1878, where he saw some experiments on dynamo-electric machines, and on his return to Menlo Park he started his experiments on a system of electric light and power, which culminated in the successful starting of the first central station, in the lower portion of New York city in September, 1882.

The Panic in Gas Shares

The public interest aroused in Mr. Edison's work and the controversy as to whether it was possible to achieve anything that would be of a commercial value is manifested by the constant reference to the matter in the public press in 1878, 1879, and 1880, resulting in a panic in gas securities in London in 1878 and in New York in 1879. Probably the work of no inventor was more generally discussed on both sides of the Atlantic by laymen and technical authorities alike than was that of Mr. Edison on his electric lighting and power system. All kinds of comparisons were made as to the difference between the cost of gas and the cost of electricity. It was declared by some that Mr. Edison could not possibly be considered as having succeeded in his work unless he could produce an illuminant that would compete commercially with gas. These objectors lost sight of the fact that the characteristics of the two illuminants were quite different, and that there was no more reason for supposing that, if electricity were more expensive than gas,[1] the cost would be a barrier to its use any more than there is reason for supposing that gas should be considered a commercial failure because the poorest classes find it cheaper to use tallow dips.

The probable reason for scientists and electricians doubting the possibility of a successful electric-lighting system being produced was that all previous experimenting on incandescent lamps had been, as I have already stated, aiming at producing a lamp of the lowest possible resistance, and consequently

1. This was written, of course, long before the introduction of the tungsten lamp and modern methods of making and selling electricity had brought about the present low price of electric lighting.

requiring the greatest possible amount of current, these lamps being run in series, whereas Mr. Edison, at a comparatively early stage of his work, realized that the first essential was a lamp of high resistance, and that the only way of approximating an even distribution of pressure was to run these lamps in multiple arc. Hence his application for a patent on a lamp with a high-resistance filament, under date of November 4, 1879, and his application on multiple-arc distribution in February, 1880. It was then but a short time before he realized that, although experimentally this might give him even pressure, the expense of the copper in his distribution system would be too great, owing to the necessity of increasing the size of his copper, as he got farther and farther from the point of generation. The result was that in August, 1880, he applied for his patent on a system of feeders to supply his system of mains at various points throughout the system, the effect being a compact system with current flowing in all directions from the central point of generation through feeders, by means of which even pressure could be maintained throughout a considerable area.

Underground Work and Three-Wire System

A still further step made by Mr. Edison was the realization that nothing very reliable in the way of a distribution system in large cities could be maintained unless the work was placed underground, and, as a result of his work of a little over two years, we find that in the early winter of 1880 Edison had a central-station system experimentally at work at Menlo Park, N. J., having an underground two-wire system, with the homes of himself and his staff electrically illumined by incandescent lamps, motors at work in his laboratory, and, in fact, all of the essential features of what is today now so common from the largest cities to the smallest villages throughout the whole civilized world.

It was but a short time after the starting of the first central station, in New York, that Mr. Edison found himself looking for some more economical methods of distribution; and I well remember his first experiments on the three-wire system, when, at

his shop in Goerck Street, New York, he placed a third brush on the neutral point of the commutator of a small bipolar Edison dynamo and demonstrated the practicability of the three-wire system.

At the same time that Edison was working on the three-wire system experimentally in New York, Dr. John Hopkinson was probably figuring out the same thing in England, and Werner von Siemens was engaged in similar work in Germany. The records of the United States, English, and German patent offices bear witness to the fact that these three men accomplished about the same results at about the same time, and, as a consequence, between 60 and 70 per cent of the investment in copper was saved.

It is not my wish to address you on the scientific or technical side of central-station development. I have thought it necessary to go at length into the early work of the art for the purpose of giving you some idea of the position to which Mr. Edison is entitled as the father of central-station work. My limited knowledge of the technique of the business would not permit me, even if I wished, to discuss the details of his early work, or of the early work of other experimenters; but I assure you that daily familiarity with the operation of one of the largest central stations in this country gives me a higher and higher appreciation of the simplicity and thoroughness and adaptability to all purposes of electrical distribution of the great work accomplished by the "Wizard of Menlo Park."

Pearl Street Station in New York

As a result of the experiments at Menlo Park, Mr. Edison, early in the winter of 1880, started to get together the necessary data for the establishment of a central-station and distributing system in New York, in the district bounded by Wall Street on the south, Nassau Street on the west, Peck's Slip on the north, and South Street on the east, a territory covering about 2,000 feet square. He had each house thoroughly canvassed to show the number of lights in use, the number of hoistways and elevators, and the horse-power of the engines

running machinery. As a result of this canvass, the Edison Electric Illuminating Company of New York was formed and drawings prepared for a central station, which was erected at 255 and 257 Pearl Street, the rating of the station being 2,000 horse-power, and the district fed by a system of half-round copper mains and feeders, the mains being enclosed in lengths of iron pipe and insulated by a bituminous compound, each length of main being between twenty and twenty-one feet, so that it was possible to take off a service at each house.

Time will not permit me to go into the details of construction of this, the first central distribution system. The boilers were placed below the engine floor and were of the horizontal water-tube type, made by Babcock & Wilcox, carrying a pressure of 125 lbs., the steam machinery and dynamos being of the direct-connected type and placed on a steel structure not dissimilar to that of some portions of the elevated-railroad structure in New York.

Great care was taken in figuring out the system of mains and feeders, an immense map of the district showing the probable consumption of current in the various parts of the territory. It should be remembered that the path to be followed was practically unknown; that electrical distribution on a large scale was as much of a hidden secret as an unexplored continent. The remarkable thing is that this first experimental system was a practical success, and a return on the money invested was being earned before electricians at home and abroad would recognize the success of the undertaking. It is but natural to find that many devices were used which were subsequently discarded. For instance, an elaborate system of resistances placed in series with the feeders was employed for maintaining an even pressure, entailing a considerable waste of energy. The lamp employed was not more than one-half as efficient as that used today[1] while the cost of manufacture was many times

1. Mr. Insull was speaking, of course, of the carbon-filament lamp as developed in 1898. A comparison between the pioneer lamps of 1880–1881 and the tungsten lamps of today (1915) would be still more marked. Probably the early lamps were not more than one-sixth as efficient as those now in everyday use.

greater, and it had not one-quarter of the life of the present commercial incandescent lamp.

Condition of the Art in 1880

It might be well to pause for a moment and picture the condition of the art at that time. I refer to the winter of 1880. The plans for the central station were completed; the details of construction of the conductors in the street were all on paper; the dynamos and electrical instruments had no existence except on the draughting board; practically nothing was known of modern methods of insulation or house-wiring; the socket and switch in use today had not been thought of, the miscellaneous devices now considered necessary in connection with house-wiring had not been considered. In addition to the development of the system and its installation, manufacturing establishments had to be created in which to manufacture the first material needed, and Mr. Edison and his corps of assistants had to abandon the experiments of the laboratory and the designing of the draughting-room to equip and manage shops in which to manufacture the apparatus necessary, from the generator to the lamp. Others have followed the beaten track, others have improved upon the methods employed, but the conception of the system, the perfecting of the original apparatus, its manufacture, its installation, and its early operation were all borne by an enthusiastic but small band of workers having an almost idolatrous belief in their chief as the pioneer of this great industry.

I have brought with me tonight a photograph of the original direct-connected steam generator known as the "Jumbo" machine, used in the Pearl Street station, composed of an engine manufactured by Armington & Sims of Providence, R. I., of the single-cylinder type, running at a speed of 350 revolutions, with what is practically the old form of Edison bipolar machine changed from a vertical to a horizontal position. The armature, instead of being wound with coils of wire, was built up of copper disks and bars. If you will glance from this to the picture of a modern central station unit composed of a com-

pound, triple, or quadruple-expansion engine,[1] with a multipolar dynamo connected directly on the engine shaft, you will find that the same broad engineering idea is alike apparent in the earliest and latest central-station unit. The improvements in dynamo manufacture have enabled us to use lower speed engines, but the broad principle of direct connection is alike the same in both. That we should come back to exactly what Mr. Edison used in the earliest central-station work is no mean tribute to him as an engineering authority.

The delay which necessarily occurs in carrying every new enterprise to a financial success acted as a wet blanket on central-station development. Efforts were made to cheapen construction when it was found that capitalists in large cities were unprepared to risk their money in the enterprise. The apparatus was adapted to the requirements of smaller communities, and, as a result, a number of small stations were established throughout the country, especially in Pennsylvania, Ohio, and Massachusetts.[2] The development of the central-station business for several years was confined to this class of work. The service was far from reliable, owing mainly to the necessity of doing the cheapest possible engineering and construction in order to meet the necessities of the slim exchequers of those who were bold enough to embark their capital in this business; but the Pearl Street station, started on September 5, 1882, with 5,500 lamps, rapidly developed, and in the fourteenth month of continuous running had 508 customers, wired for 12,732 lamps. Comparatively little work was done in central-station lighting in Europe. A small station was started in Dijon, France, in June, 1883, and in the same year installations were made in Santiago, Chile; Milan, Italy; on Holborn Viaduct, London, and in Manchester, England.

1. This was before the day of the steam turbine in electric generating-station design. See illustrations of the "Jumbo" machine and of the Harrison Street (Chicago) generating station of 1898 (with triple-expansion engines) in the chapter entitled "A Quarter-Century Central-Station Anniversary Celebration in Chicago," beginning on page 316.

2. A small station in Appleton, Wis., was opened about, or a little before, the time of the opening of the Pearl Street station.

How the Idea Spread

The success of the Pearl Street station resulted in the extension of the New York system and the building of two stations up-town in New York, one in Twenty-sixth Street, and the other in Thirty-ninth Street. This was followed by a station in Boston and another in Brooklyn. In 1887 the building of the first station in Chicago was started, the average load, as shown by the composite ampere curves of that station, being not much over 500 amperes for the year 1888. These latter stations—the two in New York, the one in Boston and the one in Chicago—were equipped with high-speed engines belted to Edison bipolar dynamos of the Siemens armature type, in some cases the engines and dynamos being on the same floor, in other cases the engines being belted to the dynamos on the floor above. Numerous other stations were started, so that by 1890 upwards of sixty cities were equipped with the direct-current low-tension system, all of which, and numerous others, are today so remunerative that their securities are considered among the most desirable local investments, especially in cities of the first and second rank.

The success of the low-tension system was followed by the introduction of the alternating-current system, using high-potential primaries with transformers at each house, reducing, as a rule, from 1,000 down to either 50 or 100 volts. I am not familiar with the early alternating work, and had not at my disposal sufficient time in preparing my notes to go at any length into an investigation of this branch of the subject; nor do I think that any particular advantage could have been served by my doing so, as it has become generally recognized that the early alternating work with a house-to-house transformer system, while it undoubtedly helped central-station development at the time, proved very uneconomical in operation and expensive in investment, when the cost of transformer is added to the cost of distribution. The large alternating stations in this country have so clearly demonstrated this that their responsible managers have, within the last few years, done every-

thing possible, by the adoption of block transformers and three-wire secondary circuits, to bring their system as close as they could in practice to the low-tension direct-current distribution system. I do not want to be understood as undervaluing the position of the alternating current in central-station work. It has its place, but to my mind its position is a false one when it is used for house-to-house distribution with transformers for each customer.

The success of the oldest stations in this country and the demonstration of the possibilities of covering areas of several miles in extent by the use of the three-wire system resulted in much capital going into the business. One of the earliest stations of a really modern type installed on either side of the Atlantic was built by the Berlin Electricity Works. The engineers of that station, while recognizing the high value of the distributing system, went back to Edison's original scheme of a compact direct-connected steam and electric generator, but with dynamos of the multipolar type designed and built by Siemens & Halske of Berlin, the engines being of vertical marine type. This was followed by the projecting in New York of the present Duane Street station, employing boilers of 200 pounds pressure, triple and quadruple-expansion engines of the marine type, and direct-connected multipolar dynamos. Almost immediately thereafter the station in Atlantic Avenue, Boston, somewhat on the same general design so far as contents is concerned, was erected. In 1891 a small station, but on the same lines, was projected for San Francisco, and in 1892 the present Harrison Street station[1] of the Chicago Edison Company was designed, and, benefiting by the experience of Berlin, New York and Boston, this station produces electricity for lighting purposes probably cheaper than any station of a similar size anywhere in this country.

Alternating-Direct-Current Combination

To go back to the question of alternating currents, the work done in connection with the two-phase and three-phase

1. Now (1915) considered obsolete and held in reserve or used as a substation.

currents and the perfection of the rotary converter has resulted in introducing into central-station practice a further means of economizing the cost of production by concentration of power. According to present experience, it is (except in some extraordinary cases) uneconomical to distribute direct low-tension energy over more than a radius of a mile and a half from the generating point. The possibility of transmitting it at a very high voltage, and consequently low investment in conductors, has resulted in the adoption of a scheme, in many of the large cities, of alternating transmission combined with low-tension distribution. The limit to which this alternating transmission can be economically carried has not yet been definitely settled, but it is quite possible even now to transmit economically, from the center of any of our large cities to the distant suburbs, by means of high-potential alternating currents, distributing the energy from the sub-center distribution by means either of the alternating current itself and large transformers for a block or district, or else if the territory is thickly settled, by means of a system of low-tension mains and feeders, the direct current for this purpose being obtained through the agency of rotary converters.

There are various methods of producing the alternating current for transmission purposes. In some cases the generators are themselves wound for high potential; in others they are wound for, say, 80 volts, and step-up transformers are used, producing whatever pressure is desired, from 1,000 to 10,000 volts. In other cases dynamos are used having collector rings for alternating current on one side and a commutator for direct current on the other side of the armature, thus enabling the operator, when the peak in two districts of a city comes at two different times, to take care of this peak by means of the same original generating unit, furnishing direct low-tension current to the points near the central station, and alternating current to the distant points. In other cases, where a small amount of alternating current is required on the transmission line, it has even been found economical to take direct current from a large unit, change it by means of a rotary converter into

alternating current, step up from 80 to, say, 2,000 volts, go to the distant point, and step down again to 80 volts alternating, and then convert again by means of a rotary converter into low-potential direct current.

The introduction of alternating current for transmission purposes in large cities is probably best exemplified by the station recently erected in Brooklyn, whence alternating current is produced and carried to distant points, and then used to operate series arc-light machines run by synchronous motors, the low-tension direct-current network being fed by rotary converters, and alternating circuits arranged with block transformers, and even in some cases separate transformers, for each individual customer in the scattered districts.

The Most Serious Problem in Central-Station Management

Passing from a review of central-station plants and distribution systems naturally brings us to the operating cost and the factors governing profit and loss of the enterprise. In considering this branch of the subject, I will confine my remarks to the business as operated in Chicago by the company with which I am connected.

Our actual maximum last winter came on the 20th of December, our load being approximately 12,000 horse-power.[1] A comparison of the figures of maximum capacity and maximum load of last winter shows that we had a margin in capacity over output of about 20 per cent. The load curves represent the maximum output of last winter (December 20th), an average summer load last year (June 4th), and an average spring load of this year (May 2d). For our purposes we will assume the maximum capacity of the plant and the maximum load of the system to be identical. The maximum load last winter occurred, as I have stated, on December 20th, about 4:30 o'clock

1. For comparison it may be mentioned that the maximum demand on the Commonwealth Edison Company, successor to the Chicago Edison Com-Company, was 306,200 kilowatts (about 410,000 horse-power) on December 15, 1914. This shows that in a period of seventeen years the maximum demand increased thirty-four times.

in the afternoon, and lasted less than half an hour. It should be borne in mind that the period of maximum load only lasts for from two to three months, and that the investment necessary to take care of that maximum load has to be carried the whole year. It should not be assumed from this statement that the whole plant as an earning factor is in use 25 per cent of the year. The fact is that, during the period of maximum load, the total plant is in operation only about 100 hours out of the 8,760 hours of the year; so that you are compelled, in order to get interest on your investment, to earn the interest for the whole of the year in about 1.5 per cent of that period, on about 50 per cent of your plant.

This statement must bring home to you a realization of the fact that by far the most serious problem of central-station management, and by far the greatest item of cost of the product, is interest on the investment. It may be that the use of storage batteries in connection with large installations will modify this interest charge, but even allowing the highest efficiency and the lowest cost of maintenance ever claimed for a storage-battery installation, the fact of high-interest cost must continue to be the most important factor in calculating profit and loss. This brings home to us the fact that in his efforts to show the greatest possible efficiency of his plant and distribution system, it is quite possible that the station manager may spend so much capital as to eat up many times over in interest charge the saving that he makes in direct operating expenses. It is a common mistake for the so-called expert to demonstrate to you that he has designed for you a plant of the highest possible efficiency, and at the same time for him to lose sight of the fact that he has saddled you with the highest possible amount of interest on account of excessive investment. Operating cost and interest cost should never be separated. One is as much a part of the cost of your energy as the other. This is particularly illustrated in connection with the use of storage batteries. Those opposed to their use will point out to you that of the energy going into the storage battery only 70 per cent is available for use on your distribution system. That state-

ment in itself is correct; but in figuring the cost of energy for a class of business for which the storage battery is particularly adapted, the maximum load, that portion of your operating cost affected by the 30 per cent loss of energy in the battery, forms under 4.5 per cent of your total cost, and it must be self-evident, in that case at least, that the 30 per cent loss in the storage battery is hardly an appreciable factor in figuring the operating cost of your product. So far as I have been able to ascertain, it would appear to be economical to use storage batteries in connection with central-station systems the peak of whose load does not exceed from two to two and one-half hours.

Influence of Interest on Cost

In order to illustrate the important bearing which interest has on cost, I have prepared graphical representations [not shown] of the cost of electricity, including interest, under conditions of varying load factors. For the purpose of this chart I have assumed an average cost of energy, so far as operating and repairs and renewals and general expense are concerned, extending over a period of a year, although of course these items are more or less affected by the character of the load factor. For the purpose of figuring interest, I have selected seven different classes of business commonly taken by electric-light-and-power companies in any large city. Take, for instance, an office building. It has a load factor of about 3.7 per cent; that is, the average load for the whole year is 3.7 per cent of the maximum demand for electricity at any one time during that period; or, to put it another way, this load factor of 3.7 per cent would show that your investment is in use the equivalent of a little over 323 hours a year on this class of business. This is by no means an extreme case. You can find in almost every large city customers whose load factors are not nearly as favorable to the operating company, their use of your investment being as low as the equivalent of 75 or 100 hours a year. Take another class of business, that of the haberdasher, or small fancy-goods store. As a rule these stores are comparatively small, with facilities for

getting a large amount of natural light and little use for artificial light. The load factor is about 7 per cent, the use of the investment being not quite twice as long as that of the office building. Day saloons show an average of 16 per cent load factor; cafetierias and small lunch counters about 20 per cent, while the large dry-goods stores, in which there is comparatively little light, have a load factor of 25 per cent and use the investment seven times as long per year as the office building. Industrial business naturally shows a still better load factor, say 35 per cent, and the all-night restaurant has a load factor of 48 per cent.

The Question of Load Factor

You will see from this that the great desideratum of the central-station system is, from the investors' point of view, the necessity of getting customers for your product whose business is of such a character as to call for a low maximum and long average use. This question of load factor is by all means the most important one in central-station economy. If your maximum is very high and your average consumption very low, heavy interest charges will necessarily follow. The nearer you can bring your average to your maximum load the closer you approximate to the most economical conditions of production, and the lower you can afford to sell your current. Take, for instance, summer and winter curves of the Chicago Edison Company. The curve of December 20, 1897, shows a load factor of about 48 per cent; the curve of May 2, 1898, shows a load factor of nearly 60 per cent. Now, if we were able in Chicago to get business of such a character as would give us a curve of the same characteristics in December as the curve we get in May, or, in other words, if we could improve our load factor, our interest cost would be reduced, an effect would be produced upon the other items going to make up the cost of energy, and we probably could make more money out of our customers at a lower price per unit than we get from them now.

Many schemes are employed for improving the load factor, or, in other words, to encourage a long use of central-station

product. Some companies adopt a plan of allowing certain stated discounts, providing the income per month of each lamp connected exceeds a given sum. The objection to this is that it limits the number of lamps connected. Other companies have what is known as the two-rate scheme, charging one rate for electricity used during certain hours of the day and a lower rate for electricity used during the remainder of the day, using a meter with two dials for this purpose. Other companies use an instrument which registers the maximum demand for the month, and the excess over the equivalent of a certain specified number of hours monthly in use of the maximum demand is sold at greatly reduced price. The last scheme would seem particularly equitable, as it results in what is practically an automatic scale of discounts based on the average load factor of the customers. It does not seem to be just that a man who only uses your investment, say, 100 hours a year should be able to buy your product at precisely the same price as the man who uses your investment, say, 3,000 hours a year, when the amount of money invested to take care of either customer is precisely the same. Surely the customer who uses the product on an average thirty times longer than the customer using it for only 100 hours is entitled to a much lower unit rate, in view of the fact that the expense for interest to the company is in one case but a fraction per unit of output of what it is in the other.

Suppose that the central-station manager desired to sell his product at cost, that is, an amount sufficient to cover his operating, repairs, and renewals, general expense, and interest and depreciation. He would have to obtain from the customer having the poorest load factor, as shown on the load chart, over four times as much per unit of electricity as it would be necessary for him to collect from the customer having the largest load factor. No one would think of going to a bank to borrow money and expect to pay precisely the same total interest whether he required the money for one month or for twelve; and for the same reason it seems an absurdity to sell electricity to the customer who uses it but a comparatively few hours a year at the same price at which you would sell it to the

customer using it ten hours a day and three hundred days a year, when it is remembered that interest is the largest factor in cost, and the total amount of interest is the same with the customer using it but a few hours a year as it is with the customer using it practically all the year around.

The Cost of Money

I have dwelt thus at length on the question of interest cost in operating a central-station system, not alone for the purpose of pointing out to you its importance in connection with an electrical distribution system, but also to impress upon you its importance as a factor in cost; in fact, the most important factor in cost in any public-service business which you may enter after leaving this institution. Most of the businesses presenting the greatest possibilities from the point of view of an engineering career are those requiring very large investment and having a comparatively small turn-over or yearly income. Of necessity in all enterprises of this character, the main factor of cost is interest, and if you intend following engineering as a profession, my advice to you would be to learn first the value of money, or, to put it another way, to learn the cost of money.

Before leaving this question of interest and its effect upon cost, I would draw your attention to the fact that while interest is by far the most important factor of cost, it is a constantly reducing amount per unit of maximum output in practically every central-station system. When a system is first installed, it is the rule to make large enough investment in real estate and buildings to take care of many times the output obtained in the first year or so of operation. As a rule the generating plant, from the boilers to the switchboard, is designed with only sufficient surplus to last a year or so. In the case of the distributing system the same course is followed as in the case of real estate and buildings, with a view to minimizing the ultimate investment. Mains are laid along each block facing, feeders are put in having a capacity far beyond the necessity of the moment, consequently interest cost is very high when a plant

first starts, except, as I have stated, in the case of the machinery forming the generating plant itself.

As the business increases from year to year the item of interest per unit of maximum output will constantly decrease in consequence, owing to the fact that each additional unit of output following an increase of connected load increases the divisor by which the total interest is divided. The result is that from year to year the interest cost of each additional unit of maximum output is a constantly reducing amount, and consequently the average interest cost of each unit of maximum output should, in a well-regulated plant, grow less from year to year until the minimum interest cost per unit is reached. This minimum interest cost is reached when the capacity of the whole system and the total units of output at maximum load are identical, although of course it will always be necessary to have a certain margin of capacity over possible output, as a factor of safety.

Constant Reduction in the Cost of Electrical Energy

This same rule, although to a less extent, applies to the operating and general expense cost; that is, the cost other than interest. To particularize, the manager's salary and other administrative expenses do not increase in proportion to maximum output of station; therefore the cost of administration per unit of output, if the business is in a healthy condition, must be from year to year reduced. There are a great many other expenses that are not directly in proportion to output, and these follow the same rule. In a well-run plant the percentage of operating expenses to gross receipts will stand even year after year, while the income per unit of output will be constantly reduced. This gives excellent evidence of the fact that the cost per unit of output is constantly being reduced, as, if it were not, the percentage of expenses to gross receipts would be increased in direct proportion to the reduction in price.

Moreover, it should be borne in mind that there are many difficulties in the way of universal use of electrical energy from a

central-station system. It is the rare exception to find a house not piped for gas and water. In the case of the latter it is almost invariably the rule that owners are compelled to pipe for water, under the sanitary code of the municipality. On the other hand, in a large residential district, it is the exception to find a house wired for electricity; consequently the output of electrical energy per foot of conductor is at the present time very low as compared with the output of gas per foot of gas pipe in any of the large cities. The expense of wiring (which must of necessity be borne by the householder) is large, and it is often a barrier to the adoption of electric illumination; but as the rule to wire houses becomes more general, the output per foot of main will constantly increase, and therefore the interest per unit of output per foot of main will constantly decrease. This same rule will apply in the case of expenses of taking care of and repairing the distribution system, although to a less extent.

If you will take into account these various factors constantly operating toward a reduction of operating and general-expense cost and interest cost, the conclusion must necessarily be forced upon you that the price at which electricity can be sold at a profit today is in no sense a measure of the income per unit which it will be necessary for central-station managers to obtain in the future. In 1881–82 it was difficult to make both ends meet with an income of 25 cents per kilowatt-hour; today there are many stations showing a substantial return on their investment whose average income does not exceed 7 cents per kilowatt-hour, showing 70 per cent reduction in price in less than two decades.[1] How far this constant reduction in cost, followed by a constant reduction in selling price, will go, it is difficult to determine; but if so much has been accomplished during the first twenty years of the existence of the industry, is it too much to predict that in a far less time than the succeeding twenty years electricity for all purposes will be within the reach of the smallest householder and the poorest citizen?[2]

1. The average income of the Commonwealth Edison Company in 1914 was about 2.05 cents per kilowatt-hour.

2. This prediction has been realized, substantially, in 1915, seventeen years after it was made.

GAS AND ELECTRICITY UNDER CONDITIONS OF 1898

If you will trace the history of the introduction of gas as an illuminant you will find that it took a much longer time to establish it on a commercial basis than it has taken to establish most firmly the electric-lighting industry. All the great improvements in gas—the introduction of water gas, the economizing in consumption by the use of the Welsbach burner—have all been made within the time of those before me. When these gas improvements were put into effect the electric-lighting business was hardly conceived, and certainly had not advanced to a point where one could claim that it had passed the experimental stage. Notwithstanding this, the cost of electrical energy has decreased so rapidly that today there are many large central-station plants making handsome returns on their investments at a far lower average income per unit of light than the income obtained by the gas company in the same community. In making my calculations which have led me to this conclusion, I have assumed that 10,000 watts are equal to 1,000 feet of gas. This comparison holds good, providing an incandescent lamp of high economy is used as against the ordinary gas burner. To make a comparison between electric illumination and incandescent gas burners, such as the Welsbach burner, you must figure on the use of an arc lamp in the electric circuit instead of an incandescent lamp, which is certainly fair when it is remembered that incandescent gas burners are, as a rule, used in places where arc lamps should be used if electric illumination is employed.

THE THRESHOLD OF A GREAT DEVELOPMENT

With such brilliant results obtained in the past, the prospects of the central-station industry are certainly most dazzling. While the growth of the business has been phenomenal, more especially since 1890, I think it can be conservatively stated that we have scarcely entered upon the threshold of the development which may be expected in the future. In very few cities in the United States can you find that electric illumination

exceeds more than 20 per cent of the total artificial illumination for which the citizens pay. If this be the state of affairs in connection with the use of electricity for illuminating purposes, and if you will bear in mind the many other purposes to which electricity can be adapted throughout a city and supplied to customers in small quantities, you may get some faint conception of the possible consumption of electrical energy in the not-far-distant future. Methods of producing it may change, but these methods can not possibly go into use unless their adoption is justified by saving in the cost of production — a saving which must be sufficient to show a profit above the interest and depreciation on the new plant employed. It is within the realms of possibility that the present form of generating station may be entirely dispensed with. It has already been demonstrated experimentally that electrical energy may be produced direct from the coal itself without the intervention of the boiler, engine and dynamo-electric machine. Whether this can be done commercially remains to be proved. Whatever changes may take place in generating methods, I should, were I not engaged in a business which affords so many remarkable surprises, be inclined to question the possibility of any further material change in the distributing system. Improvements in the translating devices, such as lamps, may add enormously to the capacity of the distributing system per unit of light; but it does seem to me that the system itself, as originally conceived, is to a large extent a permanency. Should any great improvements take place in the medium employed for turning electrical energy into light, the possible effect on cost, and consequently selling price, would be enormous.

STANDARDIZATION, COST SYSTEM OF RATES, AND PUBLIC CONTROL[1]

CALLING to order the annual convention of your association, my dual capacity causes me some embarrassment. I am in doubt whether as president to enlarge upon the great growth of this association since its formation in this city on February 25, 1885, or whether as a resident here to dwell at length upon the marvelous growth of the city in which we meet. Chicago and the industry with which we are identified have a somewhat close connection. The growth of the former, if measured from the point of view of the rapidity with which history is made, is, so to speak, the product of yesterday. The electrical industry, or rather that portion of it with which we are associated, is but little more than the product of today. If the growth of this city and that of our own industry are as great during the next thirteen years as the progress that they have achieved since the date of your first meeting here, I am sure that both the citizens of Chicago and the members of your association will have every reason to congratulate themselves. Speaking for those of my friends connected with the electrical industry in Chicago, and also for myself, I can assure you that it affords us very great pleasure to welcome you at this convention, and the fact of your meeting in this my home city enhances not a little my high appreciation of the privilege of presiding on this occasion.

1. Mr. Insull was president of the National Electric Light Association in 1897–1898. This organization is the great representative society of the electric-service interests of the United States. At the convention held in Chicago on June 7, 1898, President Insull delivered the address which forms this chapter. It was a notable contribution to the literature of the art at that time, and it has lost little of its savor with the passage of the years. It may be remarked that this is the first of these papers in which is enunciated the "exclusive" or monopoly doctrine which was later advocated so earnestly by Mr. Insull. This address was prepared in advance and read from manuscript.

The officers of your association have had in mind, in preparing a programme for this convention, the importance of bringing before you subjects of interest in connection with central-station management; and the papers to be read at our various sessions and the topics mentioned for discussion cover such a wide range that it would seem undesirable for me to occupy much of your time by way of introduction. The various gentlemen who have so kindly consented to read papers will deal with such important questions as the cost of generating and distributing the product which we manufacture, transformer economy, and the rival claims of alternating currents and direct currents as means of distribution. The many problems which you have to solve in connection with the question of public lighting, and the cost of producing electrical energy by water power, will also be discussed.

Standard versus Special Machinery

A matter that has called forth during the last year considerable discussion is the question of the use of standard apparatus and the tendency towards the specification of special machinery on the part of electrical engineers. This course is not by any means confined to large work, but is followed by some engineers whether they are designing a small isolated plant or are projecting a large, modern central station. It would seem to me to be of paramount importance to the manufacturer and user that both should co-operate in eliminating, as far as possible, from the business the necessity of building and using special types of machinery. This can only be done by the adoption of standard specifications for various standard types of apparatus. A committee of the American Institute of Electrical Engineers has already taken this subject under consideration, and I believe that we shall be serving alike the interests of the manufacturers and users of electrical apparatus if we take some action with a view to co-operating with the Institute and other bodies in this matter. In drawing attention to this subject, I speak with an appreciation of the positions of both manufacturer and user, having had more or less con-

nection with the manufacture of electrical apparatus and the manufacture of electrical energy.

Constant duplication of parts, resulting in constant duplication of a given piece of machinery, means, as any manufacturer will tell you, constant reduction in cost. Variation from a given type means increased cost and even the wiping out of an apparent profit. In the last year or so there has been a great deal of discussion in England prompted by the success of American manufacturers in obtaining large contracts for electric-traction work in Great Britain, and the inquiry has often been made, How is it possible for American electrical manufacturers, with high wages against them, to compete with English builders, whose scale of pay to their workmen is on a very much lower basis? If you will examine into the amount of electric-traction machinery manufactured in this country under a system of constant duplication and the use of special tools, and then visit the electrical establishments on the other side of the water, and note the tendency there towards specializing each particular job, you will soon recognize the reason for the lower cost here. In America this class of work is largely designed by the manufacturer, and, as a natural result, is the duplicate of something already produced; while on the other side of the Atlantic the builder of the machinery works from the plans of the electrical engineer, which necessitates his producing something different to fill each different contract. In one case, the machinery is really manufactured; in the other case, the builder runs a jobbing shop.

Unfortunately, during the last few years American users of electrical apparatus have departed somewhat from the pursuance of what is really a fundamental principle of American manufacture, namely, the use of existing types, which are turned out in large quantities with special tools, with a view to the lowest possible cost of production. The electrical engineer for the purchaser has been permitted to draw up specifications that have tended toward the specializing of apparatus, necessarily interfering with rapid manufacture and low cost of the product. The disadvantage to the manufacturer is apparent.

It is turning our large electrical works from manufacturing establishments into jobbing shops, cutting down their productiveness, increasing their labor cost and lengthening the time that it takes to produce a given article. Looking at it, therefore, from the point of view of the manufacturer, the producing power of his plant is reduced, and consequently his interest and general-expense cost is higher; his labor cost is increased; and if he finds himself unable to increase his selling price, his shop must be run at a loss instead of at a profit.

The user is necessarily interested in low cost of production on the part of the manufacturer, as he cannot expect to purchase apparatus except at prices that yield a return to the maker. From this point of view alone it would seem to me to the interest of the user that he should co-operate with the manufacturer with a view to standardizing apparatus, eliminating unnecessary variations from a given type and providing specifications for machinery calling for a given capacity at a given efficiency. Such a course would lead to low cost of manufacture, and consequently low selling price, coupled with rapid production.

Why Standardized Apparatus Should be Favored

Another objection to special apparatus is the expense and delay in obtaining duplicate parts in case of breakdown. The fear of delay under such circumstances often necessitates the user's carrying the duplication of his plant to a point entirely unnecessary when standard apparatus is used. Capital investment, and consequently interest cost, is thus increased, not only by the purchase of apparatus that of itself is expensive to build, but also by the duplication of investment which must of necessity follow.

A further point that should be borne in mind in connection with the lack of standard specifications is the opportunity that it gives to the unprincipled manufacturer to dispose of his second-rate apparatus to the uninitiated. We talk of a machine having a given "capacity" or rating; but under what conditions should it operate to develop this rating, and how

often does it occur that a dynamo-electric machine is rated entirely too high and at the cost of its efficiency? How much miscellaneous material used in connection with the industry is absolutely unfitted for the purpose for which it is sold? Surely, all of us, manufacturers and users, are interested in maintaining the highest possible standard of work and eliminating alike from our central-station systems and the installations for our customers worthless appliances whose only recommendation is their apparent cheapness, whereas, as a matter of fact, they are really the most expensive that can be bought, because they are unfitted for the purposes for which they are intended.

A proper consideration of this subject would not embrace alone the apparatus we are ourselves in the habit of buying for use in connection with our plants, but also the appliances used in connection with customers' house wiring. It should be borne in mind that faulty apparatus, from one cause or another resulting in a stoppage of the service of one or more customers, is, in the mind of the user of electricity, set down to the unreliability of the system as a whole. A central-station customer seldom discriminates between a contractor who supplies a worthless device and a company supplying him with energy. Standard specifications should therefore cover, not alone the machinery used, but also the devices and material forming part of a customer's installation. This association has addressed itself at various times to the consideration of questions in connection with house wiring, and has co-operated with the National Board of Fire Underwriters and other bodies with a view to establishing rules to be followed by contractors. I strongly recommend that this matter be taken up on a broader basis than heretofore, and that in conjunction with the technical societies we invite the co-operation of the electrical manufacturers, with a view to standardizing apparatus and the specifications therefor, whether for use in the central station itself or in connection with the distributing system.[1]

1. In view of the co-operative deliberations of the electrical and insurance interests of the United States in relation to less expensive house wiring (possibly by the use of concentric wiring) and other subjects, in progress as this book is put to press early in 1915, these utterances of seventeen years ago are particularly significant and interesting.

I do not want my remarks on this subject to be taken as in any way censuring the many electrical engineers who have by their special training and natural ability done so much to develop the industry with which we are connected. From my experience I am satisfied, however, that, from the point of view of the user, the designing engineer who adapts his requirements to the standard apparatus of a first-class manufacturer is able to produce a plant of more satisfactory character, and more economical to operate, than that designed by those engineers who are influenced by the desire to use machinery that they can point to as of their own design.

Lamp Specifications

The consideration of the subject of standard specifications would naturally include the preparation of specifications with relation to the manufacture of incandescent lamps. For several years past a committee of this association has had this subject under consideration. It has been found practicable by a number of large central-station companies, connected with another association[1] and buying from one manufacturer, to purchase their lamps under specifications that provide for the testing of samples of the product of the factory, the payment for lamps supplied being based on the results of the tests. It seems to me that it would be possible to adopt standard specifications under which our members could purchase their lamps from any reputable lamp manufacturer. The importance of this matter will be appreciated when it is remembered that the cost of lamp renewals per unit of output exceeds $1 per ton of the cost of fuel in operating a central station with the most modern steam plant.

Selling Price Based on Cost

It is of prime importance to central-station managers that they should sell their product, electricity, to the greatest num-

1. No doubt the Association of Edison Illuminating Companies and the General Electric Company are referred to here.

ber of consumers at the lowest possible price, and yet obtain a reasonable profit. For a number of years the basis of charge on the part of most companies has been a given unit price, with discounts for quantity. In the early days of the business some companies were in the habit of charging a fixed price per lamp per month, having no control whatever over the use of the product, but being necessarily responsible for the increased operating expenses caused by the wastefulness of customers, who could hardly be expected to economize, inasmuch as they paid exactly the same price for the use of light whether they burned it one or twenty-four hours a day. A majority of the companies following this method realized at an early date the absurdity of distributing that for which they were not paid, and as a result I presume we can fairly assume that the electric-lighting business (with the exception of arc-light service) is run almost universally on a meter basis.

If you will make a careful examination of the factors entering into the cost of manufactured electricity, you will realize that interest is by far the most important element, and that this item varies very considerably with the different classes of service furnished by a central-station company. The interest factor in cost depends upon the yearly average consumption of your product by the customer; or, to put it another way, you can figure your interest on the basis of so much per unit of output at maximum load.

For instance, take the two probably extreme classes of customers to whom the central-station company supplies electricity for lighting purposes. On the one hand, you have an office building whose tenants use artificial illumination for only a short space of time each day and only during the winter. On the other hand you have a basement customer whose use of your product averages nearly one-half of the day of twenty-four hours during the whole year. Your investment to take care of each of these customers is practically the same; therefore your total interest cost must be the same in both cases; but if you distribute this interest cost over the actual units consumed, you will find that the tenant of the office building

costs you for interest per unit of energy sold many times more than does the occupant of the basement. There are of necessity as many different grades of customers between the two extremes I have mentioned as there are different classes of business and different characters of structures in which these businesses are conducted. Surely, if the cost of production varies according to the different conditions under which your customers use your product, it is but fair that the selling price per unit should vary correspondingly. If it does not, you, of necessity, encourage the use of electricity by customers whose business is unprofitable to you, and discourage the use of your product by customers whose business at a lower price would yield you a fair return.

In past conventions the question of how to improve the day load for the purpose of raising the average output, what classes of business other than lighting should be encouraged to achieve this result, and the price at which we can afford to sell current to the operators of these different lines of business, have come up for discussion. At the last convention the realization of the fact that great differences exist in the elements governing the cost of product for different classes of lighting customers was ably presented by Mr. Wright, and he pointed out that the improvement of your load factor, the broadening of your curve, and the rendering less acute of your peak, are matters within your own adjustment, provided that you will realize, in considering cost with a view to making a selling price, that conditions are so dissimilar that the expense to you per unit of supplying two customers in the same block is likely to be widely different.

Various plans have been adopted by a comparatively small number of companies to meet the conditions as we now know them to exist. Some companies have adopted the scheme of allowing certain special discounts provided the income per month per lamp connected exceeds a certain amount. Other companies charge one rate for energy used during certain specified hours of the day and a much lower rate for that used during the remaining hours of the day. A third method is a system

of discounts based upon the total consumption of energy during a given period, considered in connection with the maximum consumption at any time during the same period.

These various methods all have the same object in view—the meeting of the conditions of each individual customer, and yet at the same time earning a fair return on all of the investment provided for all of your customers.

In discussing this matter I have referred to interest cost alone, because it forms so large a proportion of the total cost; but you will find that this same principle enters into a number of the other elements that go to make up your total cost. It would therefore appear to me that in considering the cost of generating electricity you should bear in mind that a large proportion of the items that go to make up the total are within your own control, and their amount per unit of output depends very largely upon the methods adopted in selling your product.

Public Control and Private Operation

A subject of growing importance to a number of our members is the question of the public ownership and operation of the undertakings now operated by electric-lighting companies. The agitation in connection with this subject has called forth a great deal of discussion, partly by those interested in it simply with a view to extending the influence of political parties, and partly by serious disinterested thinkers who believe that the best interests of the greatest number are to be obtained by the creation of a municipal socialism, which, if carried to its logical conclusion, must ultimately result in municipalities performing, with others, such public-service work as we are engaged in, and also in producing the food we eat and the clothes we wear.

To those occupied in the management of electric-lighting properties it does not seem possible that the movement in favor of municipal operation of electric-lighting plants, based upon the assumption that a municipality can produce electricity cheaper than, or even as cheap as, a private corporation, is well founded We all realize, from the close attention we have

to give to our own affairs, that self-interest and the necessity of getting a return on our investment are the first essentials to the economical administration of large enterprises. While I do not pretend to assert that electric-lighting companies are beyond reproach, I wish to point out that many of the evils complained of as pertaining to corporate management are the direct results of the enforcement of unwise conditions through legislative action. Ill-advised efforts are made often by legislative bodies to secure advantages in the direction of control which cannot be obtained without giving an equivalent in protection to the industry. This causes the investor to feel that his property is being attacked, and compels him to resist such legislation. The result is a feverish agitation, crimination and recrimination between the would-be improvers of municipal government and the owners of corporate properties without reaching a conclusion satisfactory to either.

The fallacy of the so-called reformer's theory results from looking only at what he calls the injurious effects of corporate management without taking into account its indisputable benefits. He does not seek for the cause of the trouble. If reformers will take accurate account of all the points in the problem, they will discover that the evils complained of result from errors in legislation designed to determine the relations between municipal bodies and electric-lighting companies. It seems to me that the claim that municipal operation is the universal cure for all diseases for which electric-lighting companies are supposed to be responsible merely proposes the substitution of political in the place of industrial management. This raises the question, Is the administration of municipal affairs in the various cities throughout this country so economical, as compared with the management of private industries, and the class of service rendered so efficient, as to justify the increasing of the burdens already imposed upon municipal government? It appears to me that a correct division of power and responsibility requires political government merely to control private industrial management. Where political government and industrial management are merged into one

interest, the power of control is seriously impaired, since a political administration cannot be reformed without overturning the party in power.

I cannot bring myself to the belief that the citizens of this country are in fact opposed to large aggregations of capital in corporate form, as such aggregations are absolutely necessary to the operation of all great undertakings by private enterprise. It is as impossible to operate such vast affairs with individual capital, as a personally owned business, as it is for us to live without municipal, state and national governments. The misunderstandings that from time to time occur between communities and the managers of electric-lighting companies will, to my mind, disappear entirely if the relations between the two are correctly founded on the basis of public control, with corresponding protection to the corporations operating this industry. It would seem to me to be a very proper function for this association to address itself to educating the public to a definite legislative policy that will be fair to the municipalities, securing to the public the best service at the lowest possible price, and protecting corporations by giving them franchises which, while conserving municipal control, will insure to the investor the permanency of the undertaking.

Competition is Not the True Regulative Force

It is supposed by many who discuss municipal affairs that the granting of competitive franchises for public-service work is the true means of obtaining for users the lowest possible price for the service rendered, where, as a matter of fact, the exact opposite is the ultimate result. This is proved by results in all large cities where the most severe competition has taken place. Acute competition necessarily frightens the investor, and compels corporations to pay a very high price for capital. The competing companies invariably come together, and the interest cost on their product (which is by far the most important part of their cost) is rendered abnormally high, owing partly to duplication of investment and partly to the high price

paid for money borrowed during the period of competition. The selling price of a service should be based on its cost, and in any business such as public work, where the investment is large and the annual turnover is comparatively small, if the item of interest be necessarily augmented, it must be reflected in the price paid by public and private users.

While it is not supposed to be popular to speak of exclusive franchises, it should be recognized that the best service at the lowest possible price can only be obtained, certainly in connection with the industry with which we are identified, by exclusive control of a given territory being placed in the hands of one undertaking. In most European countries public-service operations enjoy exclusive franchises, under proper control, and are able to obtain capital for their undertakings at the lowest commercial rates, thus materially affecting the cost of their product, of which interest, as I have already stated, is necessarily so great a part. In order to protect the public, exclusive franchises should be coupled with the conditions of public control, requiring all charges for services fixed by public bodies to be based on cost plus a reasonable profit. It will be found that this cost will be reduced in direct proportion to the protection afforded the industry. The more certain this protection is made, the lower the rate of interest and the lower the total cost of operation will be, and, consequently, the lower the price of the service to public and private users. If the conditions of our particular branch of public service are studied in places where there is a definite control, whether by commission or otherwise, it will be found that the industry is in an extremely healthy condition, and that users and taxpayers are correspondingly well served.

Compensation for Franchises

When prices for services are based on cost, it matters not whether or not, in the establishment of a system of legislative control, provision is made for paying a portion of the receipts direct to the municipality. If the public demands a percentage,

surely we can afford to pay it, as it would simply be added as an item of expense, on which our selling price would be figured. If the public does not demand a percentage, this selling price would be proportionately less. It is simply a question as to whether our municipal bodies prefer to raise a portion of their income by taxing their citizens through the agency of public-service corporations, or whether they prefer to raise that portion of their income by collecting it direct from citizens themselves. Revenue raised by a percentage on gross receipts of the electric-lighting business would, at the present time, however, seem to be somewhat unfairly obtained in cases where the selling price is subject to legislative control and based on cost of service, as the result would be that a small minority of citizens using electricity would be forced to contribute largely to the public revenue, whereas the benefits enjoyed therefrom would be to the advantage of the whole community.

Taking Private Property for Public Use

Another point that should be included in a proper scheme of public control is a condition under which the municipality would have the right to purchase the undertaking. Such a right should include a direct obligation on the part of the municipality to purchase the property at a fair price whenever it is thought desirable that the industry should be operated by the municipality. The possibility of the exercise of the right of purchase by the municipality would of itself make it to the interest of the owners of the property to do their full duty in their relations to the public. On the other hand, if a community licenses a corporation to perform a certain public service, and if that corporation invests money and develops its business, surely it is unfair for that community to go into the same line of public-service work itself without first purchasing the existing plant. If this is not done, the value of private property will be destroyed, without just compensation being made therefor, in an attempt to secure a public benefit. I do not believe that the people as a whole are so unfair as to demand that such a course shall be taken.

My recommendations on the subject, which I have just presented, are by no means original. Most public-service corporations in Great Britain are run on practically the bases indicated, and in more than one state in the Union corporate legislation has taken the same direction.

I would summarize in just two sentences the position that I think we should take on this subject:

First.— Franchises granted to public-service corporations should secure them the same degree of protection in their rights to their property as is enjoyed by other investments.

Second.— Public control of charge for service, based on cost plus a reasonable profit, and eliminating the factor of competition, is the proper safeguard for the interests of users, taxpayers and investors.

POSSIBILITIES OF THE CENTRAL-STATION BUSINESS[1]

THE FIRST central-station installation which I ever saw was the first one that was ever built. It was installed at Menlo Park, N. J., by Thomas A. Edison in the winter of 1880–81 for the purpose of demonstrating the success of what was popularly called the subdivision of the electric light.

The generating station was composed of nine or ten 60-light dynamos and was situated in a building beside Mr. Edison's brick machine shop at his laboratory. His workshops and laboratory and his own residence and those of his assistants were lighted by incandescent lamps. The system employed was the two-wire multiple-arc system of mains and feeders, and the distribution system was underground. There were motors at work in Mr. Edison's laboratory, and, in fact, all of the essential features of central-station generation and distribution were shown.

It was on the evening of the 2d of March, 1881,[2] that I paid my first visit to Menlo Park. I had arrived in New York from England the day before, having come on the invitation of Mr. Edison to act as his private secretary. We had heard all kinds of gossip in London about the wonderful things that were being done at Menlo Park in the way of practical electric-lighting work. Mr. Edison had been writing to his English friends

1. Although often solicited, Mr. Insull has made it an almost invariable rule not to write articles for the periodical press. Yielding to the importunities of a friend, he did, however, prepare "Some Recollections of Central-Station Development" for the Twentieth Anniversary Number of the *Western Electrician*. This article was published on September 28, 1907, and extracts from it are given here. At that time, as will be seen, Mr. Insull had formulated pretty clearly his conception of the central station as the wholesale source of electricity supply for all the needs of its community.

2. For correction in this date see note on page xxvi.

for two years prior to the date of my arrival in New York telling of his success, but as we had had no demonstration of it on the other side of the water and as scientists on both sides of the Atlantic expressed their doubts as to the results of Mr. Edison's experimental work, my natural desire when I arrived here was to pay an immediate visit to Menlo Park and cable my English friends that I had actually seen Mr. Edison's central-station system at work.

So far as the service rendered, this first experimental plant at the birthplace of the central-station industry was as perfect as the service now given by any of the central-station companies in our large cities. And although, instead of using in the generating station steam turbo-generators of a capacity from 10,000 to 15,000 kilowatts,[1] small bipolar machines of from six to ten kilowatts capacity were used, yet the main essentials of central-station engineering, as practiced today, were shown in this original and successful effort at central-station building. There was the multiple-arc distribution system with feeders running from the generating station to various points in the system of mains in order to equalize the pressure, incandescent lamps and motors running in multiple, and the street wiring system thoroughly insulated and laid underground; in fact, all the essentials of modern central-station distribution.

Diversified Duties of Mr. Edison and His Assistants

At the same time and running from the same generation station Mr. Edison had in operation about a mile of electric railway, the track being partially insulated and used for conducting the current. A speed of 42 miles an hour was attained, and over 5,000 people rode on this experimental electric railway.

I can well remember the early experiences in central-station construction in New York in the winter of 1881 and the summer of 1882. The men familiar with the work could at that time be counted on the fingers of one hand. There were Mr. Edison and three or four assistants.

1. Eight years later, in 1915, this would have been written 25,000 to 35,000 kilowatts.

After Mr. Edison got through with his experimental work at Menlo Park, he and his assistants had to pick out the territory in New York for central-station distribution, decide on the generating capacity necessary and the size of conductors required. Then, after the general specifications for the work had been prepared, it was necessary that there should be provided factories in which to build the generating machinery and underground conductors needed; also supplies, such as lamps, sockets, switches, meters, etc. All these establishments had to be started and organized and the machinery produced and put in place and the necessary central-station operating force taught to operate and take care of the central-station system.

This work — all of it — had to be done by a few men whose only experience was that gained in demonstrating experimentally at Menlo Park Mr. Edison's inventions and ideas for central-station work.

During the building of the New York central-station system I was mainly engaged in the daytime in looking after Mr. Edison's business affairs. The laying of underground conductors used to take place at night, and the work of laying was superintended by Mr. Edison and Mr. John Kruesi, the latter being occupied in the day in manufacturing the conductors, or, as they were then known, "Kruesi tubes." I was in the habit of assisting them at night, my main duty being to sit on a street corner and watch a galvanometer used in testing the tubes for insulation.

Alternating-Current and Three-Wire Development

While the direct-currect business was being exploited by the Edison companies, the Westinghouse Electric Company and the Thomson-Houston Electric Company were engaged in pushing the alternating-current business and using as a basis for it the old arc-light companies which in a number of cities had been formed mainly by the Brush Company for doing city lighting. For a number of years there was the most heated and acrimonious discussion between the champions of the two different forms of current (direct and alternating); but all this

has long since passed away, and current of both descriptions is being used by the large companies at the present time; in fact, among the largest manufacturers of alternating current in the country are the old Edison local companies, which have always kept the lead in connection with central-station development.

Some of the earliest three-wire central-station installations with overhead conductors were made at Sunbury, Shamokin and Mt. Carmel, Pa., and at Piqua, Ohio, the early three-wire underground systems in the smaller cities being laid in Brockton, Fall River and Lawrence, Mass., Rochester and Newburgh, N. Y., and Detroit, Mich. Among the larger cities, Brooklyn, Boston and Philadelphia had Edison three-wire plants in operation before any attempt was made to install large central-station three-wire plants in the West. It was not until 1887 that the Chicago Edison Company was organized by the men who originally controlled the Edison light and power patents for Illinois and some of the surrounding states. The Chicago Edison Company started with a capital of $500,000.

Latter-Day Development

In later years, the old rivalries having passed away, the Edison and alternating-current plants have consolidated, as a rule, into one organization in each city, much to the advantage of the public in the direction of lower prices and better service, and to the investor in a better return on money invested, owing to the stoppage of the duplication of investment and organization.

Today in the cities of the first rank the central-station business has got to the point of a vast manufacturing business, the tendency being to install large turbo-generators of from 10,000 to 15,000 kilowatts capacity, producing high-tension alternating current, which is transmitted to rotary substations, where it is transformed into direct current of various pressures dependent on whether it is to be used for electric-light and industrial-power purposes or street-railway work. In other

cases the substations are composed of step-down transformers to reduce the voltage to that ordinarily used for alternating electric light and power distribution.

The experiences of the last few years have shown very distinctly that if the central-station companies of the large cities are to maintain their positions, they must go more and more into the wholesaling of electricity to large users, such as street-railway companies, elevated-railway companies, and possibly later on to the larger transportation companies of the country.

All Electrical Energy for a Given Area Should be Produced by One Organization

There is no business that I know of that is benefited more than the central-station business in the way of reduced cost of production by the increased amount of output. The introduction of the steam turbine is especially conducive to the economical production of electrical energy in very large quantities, both from a capital and operating point of view; and I look forward with confidence to the day when the electrical energy required in each of our large cities will be produced under one organization for each city, with a few large generating stations for the production of alternating current, the energy being converted into whatever form may be best adapted for the purposes for which it is required.

A canvass of any of the central blocks of buildings in any of our large cities will show an amount of investment in power-producing machinery out of all proportion to that which is really required to render the service demanded within a given territory. As these plants deteriorate and go out of use, central-station connections are taking their place, leading to a saving alike of capital expenditure and operating expenses.

The same remark will apply to a canvass of the power facilities of the various companies using electrical energy, such as the street-railway companies, the elevated-railway companies and the interurban-railway companies, in any given territory.

It is easy of demonstration that the most economical thing

to do is to produce all the electrical energy required in a given territory under one organization; and the central-station company that works toward this end will, in my opinion, show a far greater return on the money invested by its stockholders and be able to quote a lower price to its customers than the company which undertakes to do the purely retail electric-light and industrial-power business of the community, as the latter forms but a small portion of the possible business offering.

ELUCIDATION OF ELECTRIC-SERVICE RATES FOR BUSINESS MEN[1]

THIS subject, instead of being dealt with in a summary way as some have suggested, has occupied the attention of the legislative department of the city government for more than two years. It came up in Mayor Dunne's administration, when an ordinance was passed by the City Council and vetoed by the Mayor, though it had been adopted after months of discussion and months of investigation, and had met with the general approval, I think, of the community. It did not, however, happen to meet with the approval of Mayor Dunne. That veto, I think, was rendered in June, 1906. Late in the autumn of 1906 Mayor Dunne asked of Marwick, Mitchell & Co., chartered accountants of this city and New York, their opinion as to what should be done in relation to an investigation of the rates of the then Commonwealth Electric

1. Nearly ten years elapsed between the latest preceding public appearance of Mr. Insull, as recorded in this book, and the occasion of this speech. The decade was a busy and notable one in the electrical history of Chicago. The historic Fisk Street generating station was put in operation in 1903. Here the large turbo-generator units which have revolutionized the methods of generating electricity had their first trial, thanks to Mr. Insull's boldness and initiative. This was the first electric generating station in the world to be equipped exclusively with steam-turbine generating units, and it became famous. The Commonwealth Electric Company and the Chicago Edison Company, of both of which Mr. Insull was president, and both of which, under his direction, had absorbed other companies, were consolidated in the Commonwealth Edison Company in 1907. (It may be stated here, as a matter of record, that Mr. Insull was elected president of the Commonwealth Edison Company at its formation, and that he still occupied that position when this book was published.) The great work of supplying the diversified electrical needs of the city from one source was well under way. Large contracts had been made with surface and elevated railway companies for supplying electricity at wholesale rates. On March 7, 1908, a contract ordinance fixing rates was pending between the Mayor and City Council of Chicago and the Commonwealth Edison Company, and it was discussed by a number of gentlemen at a luncheon of the City Club of Chicago on the date mentioned. One of these was Mr. Insull, and a condensed report of his remarks is given here.

Fisk Street Generating Station of the Commonwealth Edison Company, Chicago. At the right, above the Switch House of Fisk Street Station, a glimpse of Quarry Street Generating Station may be seen

Company and the Chicago Edison Company. Marwick, Mitchell & Co., in their report, if I am correctly informed, reviewed the rates of the two companies and pronounced them reasonable, advising Mayor Dunne that to make an investigation into their affairs—even if he had the right to make it—would be expensive and entirely unnecessary. And this report was rendered, gentlemen, by the firm of accountants who would have been employed and would have made money out of such an investigation. I don't suppose that Mayor Dunne, after his veto, would have cared to publish that as a reason for not taking any further action. At any rate, nothing further was done until the present administration[1] came into office, and the Mayor drew attention to the consolidation of the Edison and Commonwealth companies, and advised the gas, oil and electric-light committee of the Council to take the matter up. They have been at work on it more or less ever since, so that instead of being only a few months old, this ordinance has received the attention of the authorities practically during a period of two years.

Cost of Electric Lighting Decreased while Cost of Other Commodities Increased

Now, it is a simple proposition, gentlemen. It is simply a question of getting a fair return upon a given investment. We do not want anything more. The company has been in this community longer than I have, but I have been in it long enough to look around me and see at least fifty men here who know full well that all we are looking for, and all we get, is such return on our investment as no man in this room would accept on his private business.

Some of you have seen this chart (Fig. 1) in the newspapers and in the street cars. It was put out, gentlemen, for the purpose of getting business. I presume I have spent, from first to last, $20,000 in advertising that curve. Our rates in 1896 were on about an average with the rates of all the companies

1. That of Mayor Fred A. Busse, deceased.

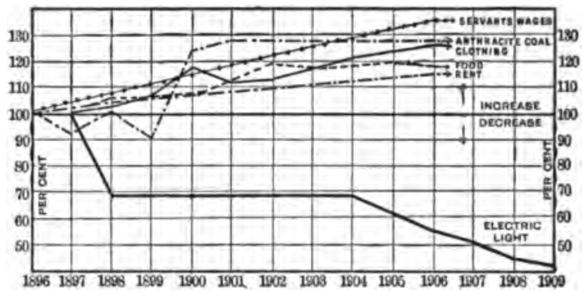


Fig. 1. Decrease in Cost of Electric Light While Cost of Other Staples Increases

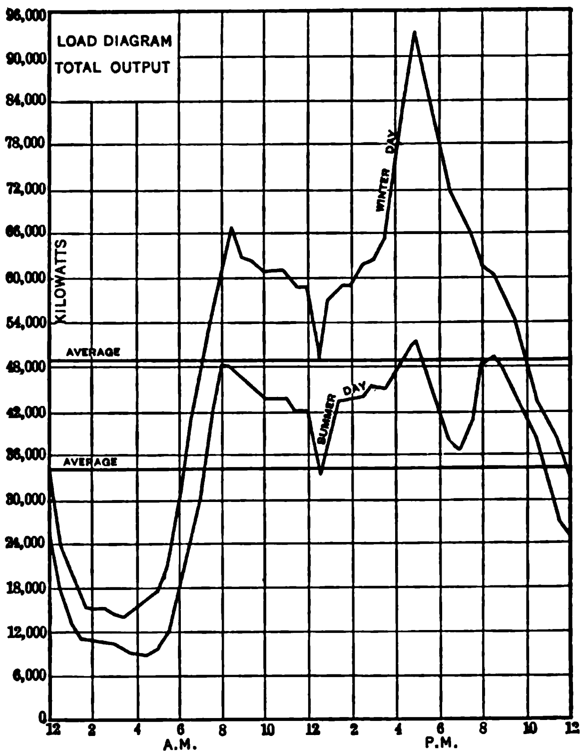


Fig. 2. Load Diagrams of Commonwealth Edison Company, 1907–1908

on both sides of the Atlantic. Practically nothing at that time was known about the cost, or the principles governing the cost, of electrical energy. We started in and, while we have not that reputation here — judging from one or two of the newspapers — outside of Chicago we have the reputation of being the pioneers in low prices for electricity. I have just this last week come back from a hurried trip to London, and while I was on the other side, as is usually the case, I was introduced to everybody as the man who was furnishing electrical energy cheaper than any one else in the world. It was, therefore, probably very good discipline to come back and have the size of my cranium reduced by reading the criticisms that have been passed on our rates during the last week since my return.

This chart shows a reduction of between 50 and 60 per cent between 1896 and 1906, covering a period when every class of material we use, every class of labor we use, has gone up tremendously in price. In August, 1907, we made a further reduction that brought our rates down to 50 per cent of what they were in 1896. Under this new ordinance they would go down in 1908 to about 45 per cent of what they were in 1896. In 1909 they will go down to about 40 per cent. What will happen after that, gentlemen, I don't know. Whether after a trial for three years of the lowest rates mentioned in the ordinance we shall be able to produce energy still cheaper, I do not know. That is a matter for the future.

Influence of Maximum Load on Rates

This chart (Fig. 2) represents the total output of our company. The lower irregular line is the load of an average day in the middle of the summer and the upper irregular line is the winter load. In summer the average load bears the relation of, say, 35,000 to the maximum of 48,000. In winter the average bears the relation of 48,000 to 95,000. Now this highest peak is the governing point of our interest account. It is the governing point of all charges that are not absolutely dependent upon the amount of our load. For instance, probably

two-thirds of the amount of coal is dependent upon exactly how much load we have on as a maximum. The other third we figure in with what we might call a fixed expense, or part of our fixed charges, just like interest.

This rise and fall determines whether we make money or whether we lose money. So close are our finances connected with our maximum load that it would be quite a possibility for us to take, for the same dollars and cents we are receiving now, business of such a character that instead of paying our stockholders a return for their money, we would absolutely lose money for them. That is the main cause, that question of the maximum load, of all the trouble in fixing electric-lighting rates. The gas company would be subject to precisely the same condition if it were not for the cheapness of storage. Storage with us is practically an impossibility. The Commonwealth Edison Company has about $1,500,000 invested in storage batteries in this downtown district. We do not carry that investment to help us out at a period of maximum load, but solely to insure us continuity of service.

Cost of Supplying Various Classes of Customers

This chart (Fig. 3) gives five different classes of consumers. The first is the small office building, where the relation of the maximum to the average load is only 10 per cent, or where our service would be equal to, say, two and a half hours out of the twenty-four. In order to break even we would have to get about 21.5 cents, or 20 cents, and then 22. With the small flat, which comes next, we come out a little better, though the consumption is still very small. We would not come out quite as well under the new rate as under the rate now in existence. Our maximum should be about 15 cents. We are getting now about 14 cents. It is proposed under the new ordinance to make 12 cents the maximum next fall, so you see we don't make much money out of small offices and small flats. With the larger flat, we can almost get out at cost on the new rates. You can take it as a certainty, gentlemen, that all that business

is a loss, figuring 6.5 per cent on money, 6 per cent depreciation, 1 per cent for taxes and 0.5 per cent for insurance.

We come next to the average store. The merchant uses light about 20 per cent of the time, or nearly five hours a day, and we begin to get a little profit out of him. As a matter of

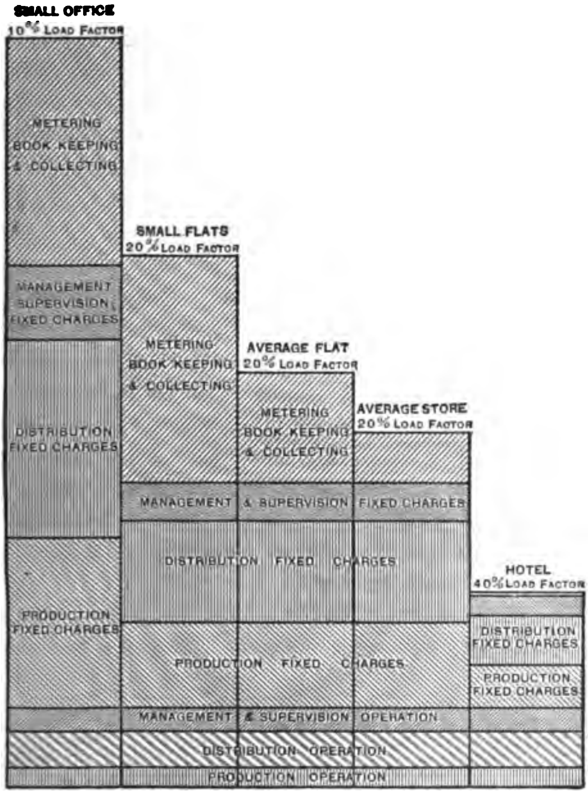


Fig. 3. Relative Cost of Electric-Lighting Supply

fact, our money is really made out of our long-hour users, people who use it 40 per cent of the time, nine and a half hours a day, and do a wholesale business.

Let me tell you, gentlemen, that the avowed policy of the company is to do its small business at a loss and make its

profits out of its big customers. An investigation of our rates, let it be ever so extensive, can only give you that information finally. It will show you that we are discriminating against the large concerns on State Street in favor of the small flats and small people in the outlying territory. I don't know that we have a right to do that, but that is the avowed policy of our company, and if it does not suit the community, all they have to do is to put up our maximum rate to about 20 cents. The big man would be protected and the small man would be compelled to pay more for his light. The same operation would give the big man a big discount. Mr. McCormick[1] says he has heard that our rates for railway power are $15 per kilowatt per year, and half a cent a kilowatt-hour. That is so, with a certain guaranty as to consumption. This is the first time it has ever been made public, but I have never objected to its being made public. It is far better for us, and far more satisfactory, than supplying private houses, because it can be done without coming in contact with any branch of the city government, and, as I have said before, any man who has had to deal with public affairs, I don't care whether it is the Mayor or the Council or the officials of the city hall, or the public-service corporation man, will tell you that the one absolutely desirable thing to do is to be able to conduct your affairs without coming in contact with the government.

A Plea for Regulated Monopoly

I want you to understand that I am very much in accord with the regulation by the proper authorities of such utilities as the one I operate. I think I am one of the first men in this community to advocate their proper regulation, but there is one great mistake that is being made at the present time. You are trying to preserve competition, and at the same time you are trying to regulate on a monopoly basis. Now, in the

1. Mr. Robert R. McCormick, then president of the Board of Trustees of the Sanitary District of Chicago. Mr. McCormick had preceded Mr. Insull in the discussion and urged further study of the subject. Except in one or two minor details, Mr. Insull indorsed what Mr. McCormick had to say.

business I manage there is no justification for competition. The building up of a separate distribution system, for instance, by the Sanitary District, is a financial absurdity. Either they ought to own us or we ought to buy their power. It is the same way with the street-railway systems. It is the only economical way to do the thing, and it has got to come finally. It has either got to come by private ownership, a monopoly thoroughly protected, with regulation of the most minute character and publication of all the figures of the operating property, or else it has got to come by municipal ownership. The latter, I think, would be a calamity, but it has got to come one way or the other. As believers in proper regulation, we have done all we could to enable the authorities to look into our affairs and to study them thoroughly and to come to a wise conclusion. The only error, I think, that has been made in the matter has been that the maximum rate is pretty low, so that we must do quite a large and growing amount of our business at a loss.

Discussion (in Abstract)

Mr. Rosenthal: I would like to ask Mr. Insull what would be necessary in order to put his business on a monopoly basis, assuming that we ought to do so.

Mr. Insull: I think it would be necessary to get some legislation before that could be done, and then probably work out some scheme not unlike the present street-railway scheme, but I think legislation would be necessary.

Mr. Walter L. Fisher: I am delighted to have Mr. Insull add his voice publicly to the doctrine which some of us have been preaching for a long time, that these public utilities should be natural monopolies under the protection of the law; that they should stand for the utmost publicity in all the details of their affairs, and that they should be effectively regulated. I think his statement, that it must be one thing or the other, is a complete exhaustion of the subject. At the same time I am hardly able to agree that it would require legislation. I think the only legislation that would be necessary to give all

the monopoly that we could give, would be legislation by the City Council, and not by the General Assembly. I know of no reason, in other words, why the Sanitary District could not sell to the Commonwealth Edison its power at a lump price, provided that power was again to be sold to the citizens at simply a fair return on the business of the company.

Of course, if it is true that the small flat and the still smaller household consumer in the chart which Mr. Insull has shown here is getting his electricity at less than cost, that raises a very interesting question as to how far it is public policy to permit that to be done. Personally it seems to me that if they fix a maximum rate, say of 15 or 20 cents for a single lamp for an hour, or whatever the unit of measurement is on this large class of consumers who only use that large rate and never would be using the secondary rate, then they should, in fixing the secondary rate, take into consideration that particular class of customers. It seems to me that this question is entitled to greater consideration, because I would assume that they represent, perhaps, the great mass of the people of this city, in numbers, at least, who are consumers of electric light. I may be wrong in my deduction from the facts, but that is what impresses itself upon my mind. Now, the question as to whether we should compel the electric-lighting company to furnish at cost, or below cost, to the small consumers as a matter of public policy is one that deserves consideration. Perhaps it is like the method which has been adopted in the use of water in this city. In most discussions of water rates it is conceded that public policy requires the furnishing of water to the small consumer even at a loss, that it is public policy to have water used by the small consumer and to make his rates low, even unduly low. I suppose that the widespread distribution and use of electric light throughout the city is a public consideration that perhaps this matter has some bearing upon. That, at any rate, seems to me to be the main question.

MR. INSULL: There are just two points I wish to speak on, and then I am through. One is our interest in having this ordinance cleaned up and out of the way. Now, we have to

raise very large sums of money. I have before me here a statement of the amount of money that we have put in year by year for the last fifteen years. I won't burden you with it, but even in this year, which is not a year when public-service corporations are trying to extend their business — but are trying rather to curtail — our expenditures this year will be somewhere between two and three million dollars for extensions. Last year they were between three and four millions of dollars. The year before they were between four and five millions of dollars, and for the year before that between three and four millions of dollars. Now, gentlemen, the agitation of this subject — its being left in the air for so long—has cost us, in my opinion, about one per cent additional for money we have had to raise in the last two years. There is no question about it. Now, we don't have to pay it. I am talking with entire candor. It comes out of the consumer finally. All we can ever expect is a fair return on money invested. My own judgment is that no public-service corporation wisely administered in the future will get much more than six per cent on its investment.[1] If the money we borrow costs us an excessive amount it is a big part of the cost of our operation, and the longer this matter is left open the more trouble we will have in raising funds. You have had a great example of that in this community. You have had here the Chicago City Railway Company and the Chicago Union Traction Company. Owing to troubles, rightly or wrongly, over the question of their life and ordinances, the properties went down from month to month and from week to week. Now, if we are put in a position where we cannot raise the necessary money on favorable terms — this business will require an average of about four million dollars of new money a year for the next twenty years to come — why, we simply cannot expect to give the service or the low prices.

1. It is probable that Mr. Insull referred here to the total cash investment. It might be added also as a fair deduction that if a company is able to borrow money at a low rate on bonds it should not be precluded from paying dividends on stock at a higher rate. Further, it may be borne in mind that the ruling rates for money at the time this statement was made in an offhand discussion were entirely different from those prevailing at the present day, seven years later.

There was one thing, I think, which Mr. Fisher said which might give an erroneous impression. He said it might be a question of public policy, selling energy for a loss to the small consumer. We started that as an experiment before there was any question of regulation. We are hoping to stimulate the use of electricity outside the center of the town, so that eventually our fixed charges might possibly be reduced, and then our cost would consequently go down. I think it would be a great mistake to change that situation at the present time. On the other hand, if you attempt to classify our rates by ordinance, you will inevitably put up the cost to the small consumer, stifle the use by the small consumer, and put down the cost to the people who can best afford to pay for it. A large consumer is well able to regulate his own price because the price has to come to a point where it will compete with his own plant.

MR. GEORGE E. HOOKER: These charts, presented to us by Mr. Insull, are the charts of the Commonwealth Edison Company. They are not the charts of a disinterested party. The charts of a disinterested party, the material, the opinion, the conclusions and recommendations of a disinterested party, are what must count; and these we lack.

MR. INSULL: If Mr. Hooker is willing, I will undertake to put at his disposal here evidence between now and the public hearing to enable him to prove the correctness or incorrectness of those charts. I do not present those charts as the president of the Commonwealth Edison Company. I present those charts as an expert in this line of business, the oldest expert in the business, and I stake my reputation on those things. They are simply absolutely true. It is not a question whether they are the charts of the Commonwealth Edison Company or the Sanitary District, or Tom, Dick or Harry. They are absolutely susceptible of proof.

CITY CLUB DISCUSSION OF THE 21,000-KILOWATT CONTRACT WITH THE CHICAGO CITY RAILWAY COMPANY[1]

MR. WALTER L. FISHER: In January, 1907, about a month before the [traction settlement] ordinances were passed by the City Council — they were passed on February 11, 1907 — the Chicago City Railway Company made a contract with the Chicago Edison Company, or the Commonwealth Edison Company, for practically all of its electrical current. I believe the amount specified in the contract was 21,000 kilowatts. * * * The Commonwealth Edison Company undertakes, for a period of ten years and thereafter, so long as the City Railway Company desires to continue, to furnish it the necessary electric power for its entire

1. One of Mr. Insull's important achievements, in carrying out in practice his theories of regulated monopoly in electricity supply, making economic use of the community's diversity factor, was the making of contracts with the electrically operated elevated and surface railways of Chicago. Almost universally the large electric-railway companies had manufactured their own electrical energy as a matter of course, and it required boldness and confidence as well as sound reasoning to convince these shrewd public-utility operators that it was to their advantage to discontinue the generation of electricity. The situation in Chicago, where a Board of Supervising Engineers was placed in charge of traction affairs in 1907, made it necessary for that body to approve a contract by which the Chicago City Railway Company agreed to purchase all its electrical energy from the Commonwealth Edison Company. On October 19, 1908, while this contract was pending, the subject was discussed at a luncheon of the City Club of Chicago. Portions of a report of that discussion are here reprinted from *The City Club Bulletin*. Dr. Charles E. Merriam, who presided at the meeting, is now (March, 1915) professor of political science in the University of Chicago and alderman from the Seventh Ward of Chicago. Mr. Walter L. Fisher, special traction counsel for the city, was afterward Secretary of the Interior in President Taft's cabinet. Mr. Bion J. Arnold, chairman of the Board of Supervising Engineers, is a past-president of the American Institute of Electrical Engineers. Mr. George E. Hooker is civic secretary of the City Club.

and complete operation. The contract is for a ten-year period, but contains a provision that whenever the City Railway Company demands additions to the service the contract is arbitrarily extended three years from the date of any such requirement. The City Railway Company must take all of its power from the Commonwealth Edison Company for seven years. From that time on the City Railway Company may manufacture its own electric power for any excess that arises after the seven years, the body of the contract running to the end of the ten-year period, but the excess being supplied by the company itself.

Why Electrical Energy is Cheap in Chicago

Mr. Bion J. Arnold (after reciting different methods by which the Chicago City Railway Company could have purchased or manufactured electricity): None was satisfactory. We couldn't afford any, though we decided it would be cheaper to build our own plant than to pay the Commonwealth Edison Company the price that that company at that time asked, which was $15 per kilowatt, primary charge, per year, and 0.5 of a cent per kilowatt-hour for the energy consumed. But the contract, as it stands today, allows the railway company to purchase its power at $15 per year per kilowatt, primary charge, and 0.4 of a cent per kilowatt-hour consumed, the difference between the 0.4 and the 0.5 throwing the decision in favor of the Commonwealth Edison Company. And I want to tell you, gentlemen, it was no easy task to convince Mr. Insull that he ought to accept that figure, but the company succeeded in doing it, backed by the engineers, who said they could not afford to pay more than that and would not. Mr. Insull finally reluctantly came to that figure, and we have the contract prepared. I believe it to be a sound and safe and advisable contract to enter into.

One thing more may be said — namely, a word or two about the facilities of the Commonwealth Edison Company to furnish this power. It is not, perhaps, generally known among non-

technical men, and it is only due Mr. Insull and his technical staff and business organization to say, that Chicago possesses the most up-to-date power plant in the world, the greatest power plant by far in capacity that has ever been built, and that power is being produced in Mr. Insull's plant for less money per kilowatt-hour than in any other place on earth. And Chicago has developed that system. That is one reason why we can afford to buy that power now, and buy it at a cost that is the same as we can produce it for ourselves, or probably a little less. It is a great thing for this country, for the technical men especially. So much so that when Europeans come over here the first place they head for is Chicago and the Commonwealth Edison plant. I mean men interested in that particular line of work.

Economic Significance of the Contract

Mr. Samuel Insull: When this contract was originally drawn, our proposition was based upon a ten-year period. It is not a good financial proposition for a less period. The City Railway consumption will run up to not less than 40,000 kilowatts, calling for an investment, in my judgment, of around $7,000,000. The total possible income from this business, over a period of ten years, if we get all the business, is $14,000,000. Anyone in this room can figure how much of that $14,000,000 has got to be spent in interest and depreciation, and how little is left for operating expenses, taxes, insurance and profits. It was only after much discussion that we made the concession relative to the last three years' increase. It is a distinct element of this contract that we shall have the exclusive right of supplying the City Railway with energy. Our price is based upon that exclusive right.

I myself and those who work with me have a decided opinion as to how the electrical energy used in a community like this should be produced. We believe that it should be produced as a monopoly, and this contract is in that direction. It means cheaper electricity for the City Railway Company; it means

cheaper electricity for the smallest user of power or light in this community, and in that respect I think we are making a record here in Chicago far in advance of what is being done in any city on either side of the Atlantic. If I were considering this contract by itself, I would not recommend to any body of financiers the providing of $7,000,000 to fulfill the conditions of this contract. I could not show them any profit in the operation by itself. It has to be taken in connection with the whole of our business, with practically a monopoly of the production of electrical energy in this community.

I was very loth to make the concession as to the last three years, and did it after Mr. Arnold and his associates had pointed out that it was an unreasonable position to put the City Railway in — namely, that they would have to build a plant to take care of their entire business on a given day; and it was on that basis that we conceded the three years' increase. We certainly would not have consented to their going out and purchasing the energy, because it would have been at absolute variance with the basis on which we were negotiating. We were negotiating to prevent a duplication of investment, and that we have accomplished in this contract.

Suppose that we are all wrong in our figures. Suppose Mr. Arnold and his office, and the Board of Supervising Engineers, and the City Railway Company are all wrong, and that this should be so advantageous a contract, netting us so much money out of it as to make it a hardship on the city, the effect, nevertheless, of this contract would be to help lower the cost of production of the energy that we sell to the smallest users. Every five years the city of Chicago has the right to regulate our rates, based on our cost, to our regular retail customers; so the thing would practically adjust itself so far as the community is concerned.

Mr. Fisher referred to a board of arbitration. The Commonwealth Edison Company, in making this contract, has placed itself in a position practically where it nominates one member of a board of three arbitrators, and the other party to the contract (because, after all, the interests of the city and the

interests of the City Railway Company are identical) has the right to appoint the other two members of the arbitration board.

Why the Edison Company Can Afford to Sell so Cheaply

Mr. Arnold: There is one point which I did not make clear, as to how the Commonwealth Edison Company can afford to produce this power at the cost the railway can make it for, and at the same time make a profit. The first element in it is that the Edison company is in business on a large scale, manufacturing power and selling it throughout the city. Of course, it can manufacture at a very low cost, as I previously pointed out.

The other point is that the Chicago City Railway Company would have to produce its power in units of about 5,000 kilowatts capacity each, in order to have units that would divide up during the 24-hour load period, shutting one down and starting others up, so as to make them work economically during that period. The load, you understand, on the railroad is very high in the morning, down through the day and high again in the evening, and down again in the night. To handle that kind of a load would require electrical units of about 5,000 kilowatts capacity. The Commonwealth Edison Company, however, is now installing electrical units of 14,000 kilowatts capacity,[1] nearly three times as much, you see. The cost of the kilowatt capacity of an electrical plant varies with the size of the unit. The smaller the unit the higher the cost per kilowatt, consequently the larger the unit the lower the cost; and, therefore, the investment Mr. Insull has to make in this plant is less per kilowatt than the Chicago City Railway Company would have to make.

The difference in the fixed charges on that investment, and the difference in the cost of operating large units, which take fewer men per kilowatt-hour output, makes just the difference between what it would cost the Chicago City Railway Company

1. Seven years later this figure of 14,000 kilowatts rating in generator units could be changed to 30,000 kilowatts.

to make this electricity and what it would cost Mr. Insull to make it; and that difference is Mr. Insull's profit.

Effect of Periodicity Explained

Mr. George E. Hooker: I would like to ask Mr. Arnold if the different form of electricity produced by the Sanitary District would stand in the way of its being utilized on the West Side? (Referring to Chicago Railways Company.)

Mr. Arnold: Yes, sir.

Mr. Hooker: So it is not any more likely to be used there than anywhere else?

Mr. Fisher: I don't know whether Mr. Ellicott[1] is in the room, but the estimate given to me was that reduction would add about 13 per cent to the cost.

Mr. Hooker: Then I would like to ask Mr. Arnold, if it is a proper question to ask here, why it is that those methods are different?

Mr. Fisher: Why is one 60-cycle and the other 25?

Mr. Arnold: The reason is this: This question of frequency has been a subject of debate among engineers ever since we started in on electrical work. We started in with 120 cycles, the idea being that the higher the frequency the better the energy is for electric lighting. We started in with electric lighting, you understand. As the frequency comes down, the poorer it is for lighting. When it gets down to 25 cycles you can see the fluctuation in an incandescent lamp. You can run lamps on 25 cycles, but they are not satisfactory; consequently, plants that are installed for lighting purposes only are usually installed with a moderately high frequency. To get at something that could be used for power in small quantities, and for lighting also, the standard has become 60 cycles for lighting. You can run 60-cycle motors. Sixty-cycle motor-generators or rotary converters are being used for railroad purposes, but none of them has been constructed yet above 500 kilowatts. Very

1. Electrical engineer of the Sanitary District of Chicago.

few have as much as that. Most of them are about 250 kilowatts, and are not giving entirely satisfactory service.

With the state of the art such that we cannot buy those rotary converters above 500 kilowatts — the size the Chicago City Railway Company is using now being 2,000 kilowatts — you see it is impracticable for us to consider 60 cycles in the railroad business. The 25-cycle frequency is better for power purposes. The lower the frequency, the better for power purposes. Consequently, we have two antagonistic elements working there, the higher frequency the better for lighting, the low frequency the better for power.

So we tried to harmonize them to 60-cycle frequency for lighting and small power. Railway work we have cut down to 25 cycles. All of the machinery installed for the Chicago City Railway Company and for the Chicago Railways Company is at 25 cycles; consequently if we buy power from any other source that produces it at any different frequency, we have got to put in a motor-generator or rotary converter. The cost of that machine, with interest, depreciation and operating charge, makes this difference in price.

How the Edison Company Met the Question of Frequency

Chairman Merriam: I would like to ask Mr. Insull how the Commonwealth Edison Company combines those two things, the lighting and the power?

Mr. Insull: Part of the answer I would prefer not to give, because I do not care to get launched on the subject of criticism of competitors.

When the Commonwealth Edison Company, or, rather, its predecessor, came to the conclusion that what it wanted to do was to monopolize the production of power in this community, it also came to the conclusion that the easiest way to do that would be to give the very large users of power their energy with the least possible conversion; and, where conversion is necessary, to confine it, as far as it possibly could, to its own business.

In any event, in order to deal with the business in the down-town district, our company would have to convert, whether we produced 60 cycles or 25 cycles, as we convert from alternating current to direct current. The problem before us was how to deal with the territory outside the center of town, where you distribute over a much wider area and supply in much smaller quantities, except for such large consumers as the street and elevated railways, and certain very large manufacturers. We decided it was better to confine the conversion to our own stations; and for lighting purposes we converted outside of the center of town from 25 cycles to 60 cycles.

Mr. Arnold: You generated at 25 and converted it?

Mr. Insull: We generate at 25. The wisdom of that decision is best shown by my stating that more than 70 per cent of our production is used as 25-cycle energy by our customers.

THE LARGER ASPECTS OF MAKING AND SELLING ELECTRICAL ENERGY[1]

MY THEME for this evening relates to no new subject. It is one we have been discussing for many years — the question of rates, the question of how to sell our manufactured product. There are a number of essentials which we must know before we can decide upon the selling price. We must know, first of all, the cost of manufacture. We must know the elements that go to make up that cost and whether we have the most economical possible plant with which to produce our goods. Let me say, in passing, that the very best monument that any of you can erect, indicating the successful operation of your business, is a first-class junk pile. I do not think there is any country where manufacturing is carried to a higher economical point than in the United States; but I am sorry to say that I think that there are but few manufacturing businesses in the United States where the tendency of the proprietor is to hold on to his uneconomical machinery to the extent that a number of our friends in the electric-lighting business hold on to their uneconomical manufacturing plants.

1. An address delivered before the Association of Edison Illuminating Companies at Briarcliff, N. Y., on September 1, 1909. This important utterance indicates the breadth of vision which Mr. Insull had now attained in relation to the economics of electric service. On this occasion the author, for perhaps the first time in addressing an audience, spoke in positive terms on the larger aspects of the electricity-supply business. He expounded the fundamental laws of the central-station industry before the leading men engaged in that industry, and it took some courage to advocate conceptions and methods that were almost revolutionary. The philosophy of the unified or syndicate operation of electric central-station properties is set forth here with ability and candor. The importance of diversity factor is emphasized in this and succeeding papers. The speaker was not without the courage of his convictions, for within two or three years he had engaged in the unification of electric-service properties on a much more extensive scale than ever before.

We assume that we are in the business of controlling the generation of energy in the communities in which we live. My figures are necessarily taken from my experience in Chicago; but let me tell those of you who run small plants that my experience in operating small plants leads me to the conclusion that the same principles that govern the business in its operation in a city of over two millions of people also applies to cities from 25,000 up to, say, 200,000 people. The situation in Chicago is this: Our output for the year ended June 30, 1909, amounted to 414,000,000 kilowatt-hours.[1] We did a fair proportion of street-railway business. Our light-and-power business (that is, the ordinary business run by electric-lighting companies throughout the country) amounted to 184,000,000 kilowatt-hours, while our street-railway business amounted to 230,000,000 kilowatt-hours, so that of the 414,000,000 kilowatt-hours generated, more than half went to street railways. In addition to the amount bought from us, the street-railway companies probably produced themselves 230,000,000 kilowatt-hours, so that if we had had their entire business, and added it on to what we produced, our output would have reached the imposing figure of 644,000,000 kilowatt-hours.

Stop for a moment and consider what a small proportion of the production of energy goes to the ordinary electric-light-

1. For comparison, it may be stated that the Commonwealth Edison Company generated the great total of 1,114,000,000 kilowatt-hours of electrical energy in the calendar and fiscal year ended December 31, 1914. This is probably the largest output of any individual electricity-supply system in any city in the world. Of the amount mentioned 642,000,000 kilowatt-hours was for railway customers and the remaining 472,000,000 kilowatt-hours was for light-and-power customers. Comparing the reports of June 30, 1909, and December 31, 1914, it will be seen that in the period of five and one-half years the total output increased 169 per cent, the railway output increased 179 per cent, and the output for light-and-power customers increased 157 per cent. Practically all of the electrical energy required by the surface street railways and elevated railways of Chicago is now (1915) supplied by the Commonwealth Edison Company. At the same time industrial users and small consumers have been assiduously cultivated, for the total number of customers on the company's books on February 1, 1915, was about 254,000. The rates for the smallest residence customers are ten, five and three cents a kilowatt-hour, depending on the number of hours' use of the maximum demand. Thus the electrical situation in Chicago would seem to confirm the essential soundness of Mr. Insull's doctrines in relation to electric service.

A Row of Ten 12,000-Kilowatt Vertical Turbo-Generators in Fisk Street Generating Station of Commonwealth Edison Company, Chicago

and-power customer. We in Chicago have the credit, rightly or wrongly, for pushing our business with reasonable vigor, but the above figures show that if we had all the street-railway business, our ordinary light-and-power business would amount to less than one-third of the whole. And that is not the whole story of the amount of energy produced. Our estimate is that isolated plants, manufacturing plants, industrial plants and other consumers offer the possibility of 405,000,000 kilowatt-hours yet to be obtained. This does not take into consideration the growth of the city at all; the consumption of electricity mentioned is right at our door. If we can produce it economically enough, and if we discover the right way to sell it, there is a block of 400,000,000 kilowatt-hours that we should secure.

Supplying All the Demands of the Community, Including Railways

Take another phase of the question — the electrification of the terminals of the steam railroads. All we can do in this case is to estimate, and our estimate is that it would take about 205,000,000 kilowatt-hours to take care of the steam-railroad terminals centering in Chicago. All that energy should be produced by one concern, and such will be the case eventually. There is no more reason for the existence of a series of different generating stations in a city than there is for the existence of a great many isolated gas plants in a community. If all that energy were produced by one organization (I care not whether it is the local electric-lighting company, or whether that company buys power from a power company), we could get down to rock-bottom in cost of production and consequently rock-bottom in our rates of selling. The trend of the times is toward concentration of production; it is inevitable that it must come. Ours is a business which is a natural monopoly. It matters not what the legislation of the moment may be, what the opinions of the politicians may be, what our own opinions may be, eventually, all the electrical energy for a given area must be produced by one concern.

The total demands under consideration would amount to 1,254,000,000 kilowatt-hours in Chicago. Take that on a percentage basis. The total light-and-power business of a company as large as the Commonwealth Edison Company, having invested in its business somewhere between $55,000,000 and $60,000,000 in cash, amounts to 14.7 per cent of the whole. The street-railway business amounts to 36.6 per cent of the whole. The isolated plants and the industrial-power business that we have not yet got call for 32 per cent (more than double our existing business), and the steam-railroad consumption would amount to 16 per cent. You will notice that the steam-railroad consumption is the smallest with the exception of the present electric-light-and-power business.

I was discussing this subject with one of my friends this evening, rehearsing on him a little, and he said: "You cannot get all that. Conditions are such that you have been able to get part of it in Chicago." The fact is that in the course of some three years we have been able to sell a great amount of energy — I am talking kilowatt-hours, not dollars and cents — to the street railways and the elevated railways, notwithstanding the fact that the franchise-ordinance condition of the surface street railways of the city of Chicago are such that they are able to raise their money on a better basis than any public-service corporation in this country, with probably the exception of three. It was no case of their needing our assistance to finance them; they have practically the credit of the City of Chicago, whose credit must necessarily be high, because the debt of the municipality is lower, probably, than that of any city of its size in the world, in proportion to population. The street-railway companies have practically the credit of the city pledged behind them; their financial arrangements are made with the leading bankers of the country; and it is much easier for them to raise money in amounts of $10,000,000 and $20,000,000 than it is for any of us in this room to raise it in single millions. It was no case of necessity. It was a case of demonstrating that it was the best thing for the railway companies to do; that it was the best thing for us to do, and,

perhaps, of taking some chances as to what the outcome would be. We naturally had to theorize on it at the start. We knew little or nothing of what the results would be; it was purely an experiment on our part. The impression has gone out among some of our friends that we were able to take advantage of a peculiar situation, so far as finances were concerned; but that impression is entirely an erroneous one; and I want to get that out of your minds before going ahead with any further explanation.

Analyzing the Cost of Production

Let us consider the cost of production. Fig. 1 represents the cost of supply, divided, as you see, into three parts — operating charges, fixed charges and the total of the two. You will note also that different symbols are used in the diagram to indicate the cost of supplying the street railways, the average residence using carbon lamps and the average residence using tungsten lamps. Energy sold to street railways is delivered at the substation. We have practically a single cable, or in some cases two cables, to each substation. The metering is

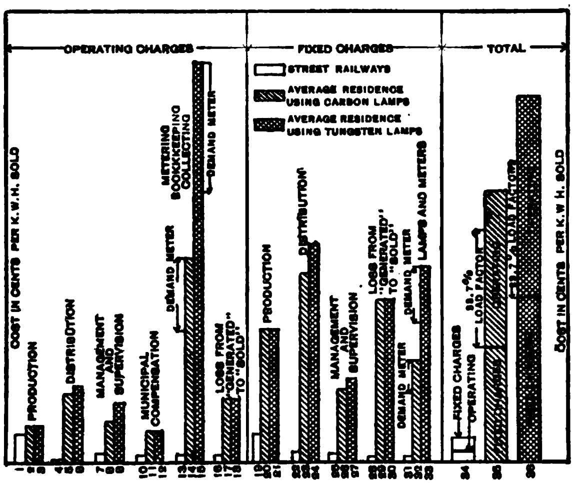


Fig. 1. Analysis of the Cost of Producing Electric Service

done at our switchboard. The amount of electricity we sell to street railways, 230,000,000 kilowatt-hours, is divided, I think, among six or eight customers. Necessarily, the cost of production runs up pretty high. Column 1 of Fig. 1 represents the energy supplied to the street railways. Column 2 represents the production cost of the average residence lighting using carbon lamps and column 3 represents the average residence lighting using tungsten lamps. The difference in cost of production is not great. I mean now the difference in the cost of the energy generated at the station, based on metering at the switchboard; but when you come to the distribution expenses, you will notice that column 4 is so small that it can hardly be seen. Column 4 represents the distribution cost of the street-railway business. So columns 5 and 6 represent, respectively, the distribution cost of the average residence using carbon lamps and the average residence using the tungsten lamp. The same remarks, you will note, apply to management and supervision. (columns 7, 8 and 9) and the same, necessarily, to municipal compensation (columns 10, 11 and 12).

When we come to metering, the cost of metering the railway business (column 13) is but little more than the cost of distribution (column 4), whereas, by contrast, the cost of metering the ordinary residence runs up as shown by column 14 and the cost of metering residences that use the tungsten lamp runs still greater, as indicated by column 15. The comparison in the loss from "generated" to "sold" is shown by columns 16, 17 and 18. This loss is practically nothing in the case of the street railways, because our energy is sold at our own switchboard, and the loss in the other two cases must be precisely the same.

Consider now what is the biggest item, what is usually the biggest item, of our expense. You will notice that our fixed charges — that is, interest, depreciation, insurance and taxes — are a little less (column 19) than our cost of production (column 1), in the case of the street railways, and very considerably more (columns 20 and 21 compared with columns 2 and 3) in the case of residence customers. In distribution, the fixed

charges (columns 23 and 24) are very heavy indeed in the case of residence lighting and very low in the case of the street railways (column 22). So this goes on all the way through, until you put the two together. Column 34 represents the total cost, fixed charges and operating charges, for the street-railway business. Column 35 represents the total cost of the ordinary customer using carbon lamps, with a load factor of about 33 per cent, and column 36 represents the total cost of the user of tungsten lamps. If you will bear this graphic comparison in mind, the enormous difference in cost between column 34 and either column 35 or 36, it will be apparent to you that our selling price is not really as low as it appears. We sell our electricity to railways on a basis of $15 per maximum kilowatt per year, figured on an average of morning and evening power maxima. In addition, in the case of a company where we get, say, from 5,000 to 10,000 kilowatts, we charge 0.5 of a cent per kilowatt-hour, and in the case of a company where we get 30,000 kilowatts or over, we charge 0.4 of a cent.

Load Factors of Railway Customers

The curves of Fig. 2 represent the cost of electricity to a railway company under different conditions of load factor. We adopted a rule, in selling to the railway companies, that we would not take any business unless we got a guarantee of 35 per cent load factor; that is, that the average use should be equal to 35 per cent of the maximum. Our reason for adopting that rule was that we came to the conclusion that the average load factor of an electric-lighting company was somewhere around 30 per cent. Some companies show figures a little above that and some of them a little below, partly owing to local conditions, but more largely owing to the ability with which the product is sold. We made up our minds, in trying the experiment, that we did not care to take any business that would interfere with our load factor. We wanted it improved in any event. We used to talk very glibly at that time about the diversity factor, but we, of course, knew absolutely nothing

about it, as we had no experience in selling large volumes of energy to a few customers.

When we were "up against" the proposition of taking the entire business of a railway company, as we have been in the case of the Chicago City Railway Company, we came to the conclusion in that case we had to take the risk of their business, and we had to take whatever load factor the business gave. We

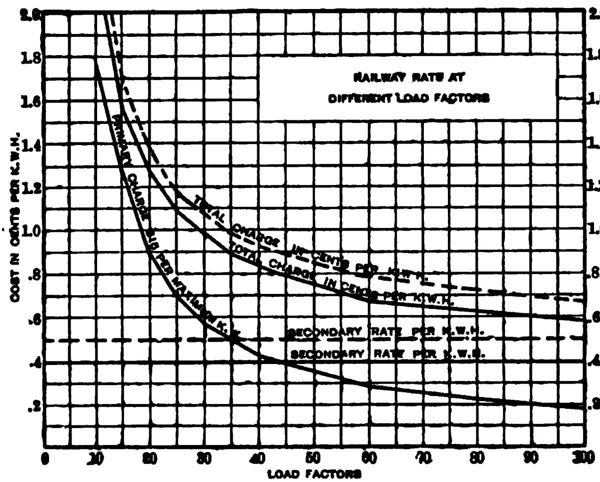


Fig. 2

had some confidence in taking that risk, because we knew if we had their entire business, from the experience we had in dealing with part of the business, the load factor would be better than 35 per cent, and the tendency would be to improve the general load factor.

In actual experience we found that selling the Chicago City Railway Company, doing practically all of their business, and in dealing with them for a year and selling them 27,740 kilowatts of maximum demand, the load factor was 48.7, and that they paid us a rate of 0.77 cent per kilowatt-hour for the energy delivered at our switchboard, we standing the cost of production and the investment in the cable for transmitting the energy to their substation. We also found there was far more

profit for us in business at that price than there was in business at a much poorer load factor at 1 cent or 1.25 cents per kilowatt-hour.

Apparently Low Rates May Mean Good Business

Our experience with the Chicago Railways Company, which for the last year has paid 0.5 cent for the secondary charge, instead of 0.4 cent, was that in selling it 15,820 kilowatts of maximum demand we got 42.6 load factor at an average price of 0.9 cent per kilowatt-hour.

Those figures may seem somewhat appalling to some of you who are selling your product in small quantities, either as direct current or as alternating current. When I speak of small quantities, I am speaking relatively; I mean to power customers using, say, 100 or 200 kilowatts. But I am sure there are a number of gentlemen in this room who would not hesitate to take a contract that would yield them $10,000, $15,000, $20,000, or $30,000 a year, dependent on the size of the town largely, and whether the system was underground or overhead, quoting a price from 2.5 up to 3 cents per kilowatt-hour for energy delivered to the customer. If you will take our rates and figure on the generation of electricity and the delivery of it to the customer's side of the meter, you will find that the rate of $15 per kilowatt of maximum demand a year, plus 0.5 of a cent per kilowatt-hour, without the large amount of investment you have to make to take care of your average industrial customer — you will find that that business, which we take at that apparently low rate, is really better business than you take when you quote a manufacturer, say, 2.25 or 2.5 cents per kilowatt-hour. For one thing, our load factor is almost twice as good as that of the average manufacturer. He will tell you that he is running twelve hours a day and uses power all the time; but when you get right down to it you will find his load factor somewhere about 20 per cent. I know that any of you who have figured on that subject will bear me out in what I say.

THE EFFECT OF TAKING STREET-RAILWAY BUSINESS

I will leave the question of cost and selling price for a few minutes, and show you some of the effect that this class of business has had upon our load curves. Take, for instance, the bearing of the monthly load factor on your cost of station production. Fig. 3 gives an example of that. You will see the load-factor curve of our light-and-power business, with the variation, month by month. The New York Edison curve

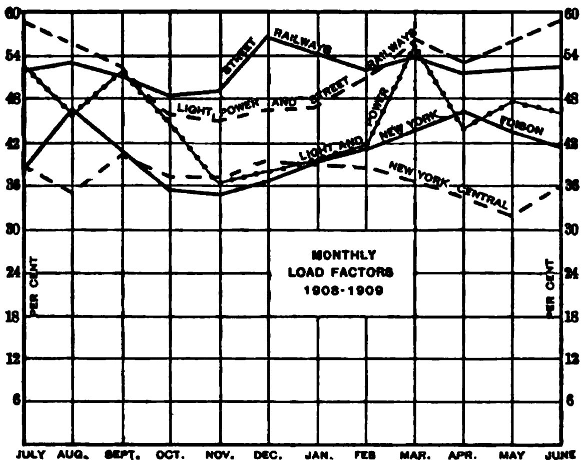


Fig. 3

is shown, also our street-railway curve, and the light-and-power and street-railway business of Chicago combined. You will see what an important bearing that must have necessarily on our cost month by month, as the combination of our business and the street-railway business produces a result in our monthly load factor which is very gratifying to us. Take, for instance, the low point. Our light-and-power load factor in November by itself would be 36, and yet when combined with the street-railway business it goes to over 44. The same result is shown in the effect upon our annual load factor.

I started some six years ago, I think, to take the first busi-

ness of this character. I think my negotiations started some time in 1902 or 1903. In 1899 our load factor, when we did nothing except the ordinary line of business, was a little over 28. Referring now to Fig. 4, you will notice that the annual load factor of our light-and-power business stood even for some time. Then we began to take advantage of the experience we had with starting the railway business; we began to take courage, and we started to lower our rate in the industrial-power business. Thus our load factor for light and power alone

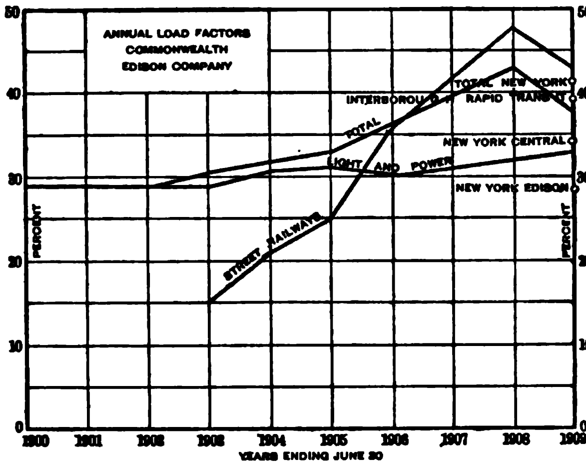


Fig. 4

gradually crept up until it was about 33. What has been the effect of our taking the street-railway business? It has been a steady climb up to 1908. It went down a little in 1909 owing to temporary reasons, but we are still above 40 per cent. The comparison there is practically the difference between 30 per cent and 40 per cent. Now, what does that mean, gentlemen?

Suppose you have, as we have, fixed charges on about $50,000,000 of investment. Take interest and depreciation, 10 per cent, that is $5,000,000. Suppose that our business was confined entirely to the ordinary lighting-and-power business, outside of the railway business. That $5,000,000 in interest

and depreciation would have to be spread over a business where the average use of your investment is only 30 per cent of the time, practically. What is our present situation? Our interest and depreciation are spread over 40 per cent, rather than 30 per cent, a difference of 10 per cent. But, you may say, that is only 10 per cent. But what does it really mean? It means that the divisor is one-third more and the reduction in fixed charges and depreciation in proportion to the dollars invested is proportionately less.

Not Merely a Question of Local Conditions

That is a result that you can all obtain. It is not any question of local conditions. If it is impossible for you to obtain it; if you cannot get the total generation of electricity in the community in which you live, or so shape your policy that that is eventually where you will come out, the wisest thing that you can do, if you have your own money invested in the business, is to sell out to the fellow who is the larger producer of electricity in your community; just the same as if you were a small manufacturer, if you could get a satisfactory price, you would be anxious to sell out to the big concern which did 90 per cent of the business. It is inevitable, if you take the street railways alone in any community, that they will be by far the larger producers of electricity, unless you can get the job of producing their product, because unless you can get that job, it is an impossibility for you so to arrange your cost of production on a sufficiently low basis for you to quote a price for the industrial-power business in your community that will really give you the business. To my mind there is no question about that; it is a gospel I have been preaching to my board of directors for some ten years past. I have taken the ground that we have got to be the main producers of electrical energy in our community, or else the other fellow has got to own us.

I think I can give you an example of that situation which occurred in the city of New York a number of years ago. What was known as the "Whitney Syndicate" acquired all

the street railways of that city. The old Edison Electric Illuminating Company of New York had been well handled and had a fine business, but when the Whitney syndicate acquired the street railways the people back of it gave out the information that they were going into the electric-lighting business, and the best bankers in this country came to terms very quickly and sold the Edison Electric Illuminating Company of New York. They did not know exactly then that this would be done; they were only scared; but the fact was that if the Metropolitan Street Railway Company, as then threatened, had gone into the electric-light-and-power business, it would have been but a few years before it would have been able to sell electricity on a much lower basis than the Edison Electric Illuminating Company, because it would have had the conditions, as I will show you a little later, that go to make low cost of production, and consequently low selling price. The old Edison Electric Illuminating Company of New York had not that condition and could not possibly have it. Financial conditions have changed the situation somewhat, so that the New York Edison Company has no reason to be afraid at the moment.

I want you to understand that to my mind it was a case of absolute necessity that we should dominate the energy-production situation in Chicago. We have not got there yet, but we are getting there gradually.

The Diversity Factor

Now, I will turn to another side of the subject. I am not an engineer, and I cannot talk technical terms as some of you people can, so if I slip up in discussing such a term as "diversity factor" you will have to excuse me. Fig. 5 shows the actual conditions, so far as the light-and-power business and the street-railway business we do in Chicago is concerned. We have estimated the steam-railroad consumption, partly on experience that we have been able to obtain from the New York Central Railroad and other railroads, and partly by taking the

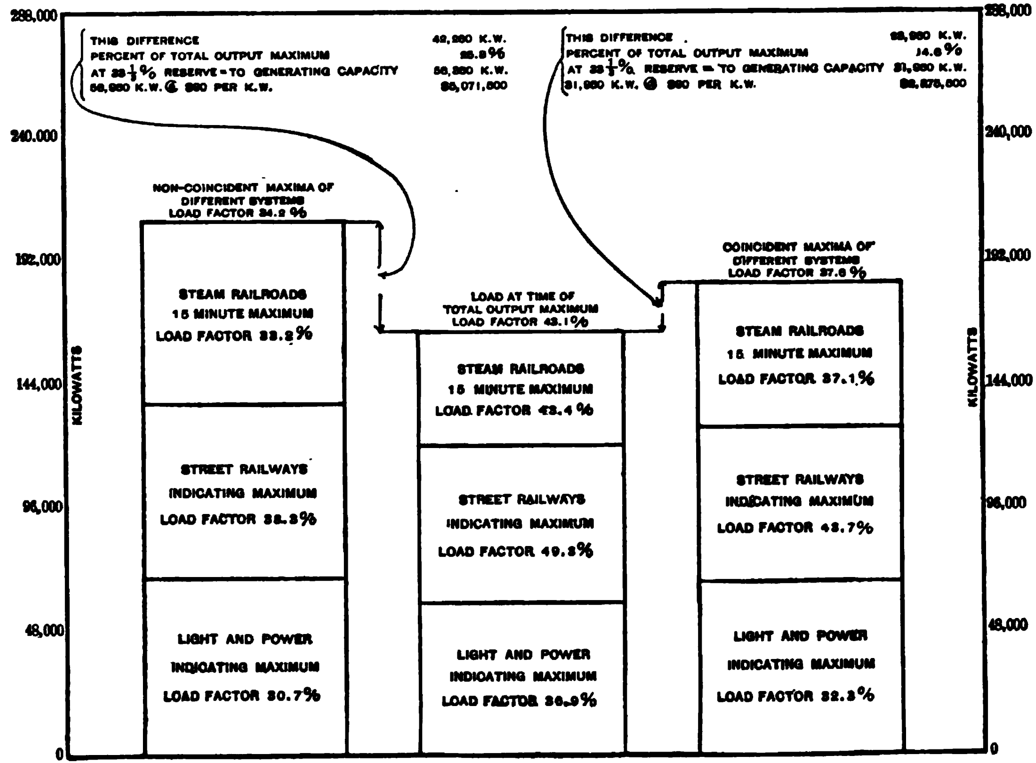


Fig. 5. A Study of Diversity of Demand in Chicago under the Conditions of 1908-1909

Interstate Commerce Commission's statistics of income and working out the probable consumption of electrical energy from the income basis. Of course, all we have to do, so far as providing the investment is concerned—and as you noted in Fig. 1 the largest items we have are investment expenses — is to provide the necessary plant to take care of the maximum load that we may have at any one time during the year. Fig. 5 represents, among other things, our load at the time of our total-output maximum for the year. The column on the right represents the coincident maxima of different systems. The column on the left represents the non-coincident maxima of the different systems. What we have to provide money for, and therefore the item that, when you get down to it, comes into the question when we are figuring our cost, is the situation shown by the column in the center. You will notice there we have a load factor of 43 per cent. The non-coincident maxima of the people that we serve, assuming that we are serving steam railroads, show a total maximum of 25.8 per cent greater than the maximum we would have at the period of our maximum load.[1]

Conditions under which we actually sold energy to railways are shown in Fig. 6. We have no steam-railroad customers, and Fig. 5 gives an assumption based on our expectation of getting some in future. Fig. 6 shows conditions under which we actually supply. The highest coincident maxima of the street railways occurred on the 15th of February. Taking the highest maxima for each of the separate companies, they came

1. In the original chart the following information was given in tabular form:

	Steam Railways	Street Railways	Light and Power	Total
Non-coincident Maximum Kilowatts.	69,300	68,650	68,310	206,260
Kilowatts at Time of Total-Output Maximum	53,900	53,300	56,800	164,000
Difference	15,400	15,350	11,510	42,260
Percentage of Difference	28.6	28.8	20.3	25.8
Coincident Maximum Kilowatts	63,000	60,010	64,950	187,960
Kilowatts of Time of Total-Output Maximum	53,900	53,300	56,800	164,000
Difference	9,100	6,710	8,150	23,960
Percentage of Difference	16.9	12.6	14.3	14.6

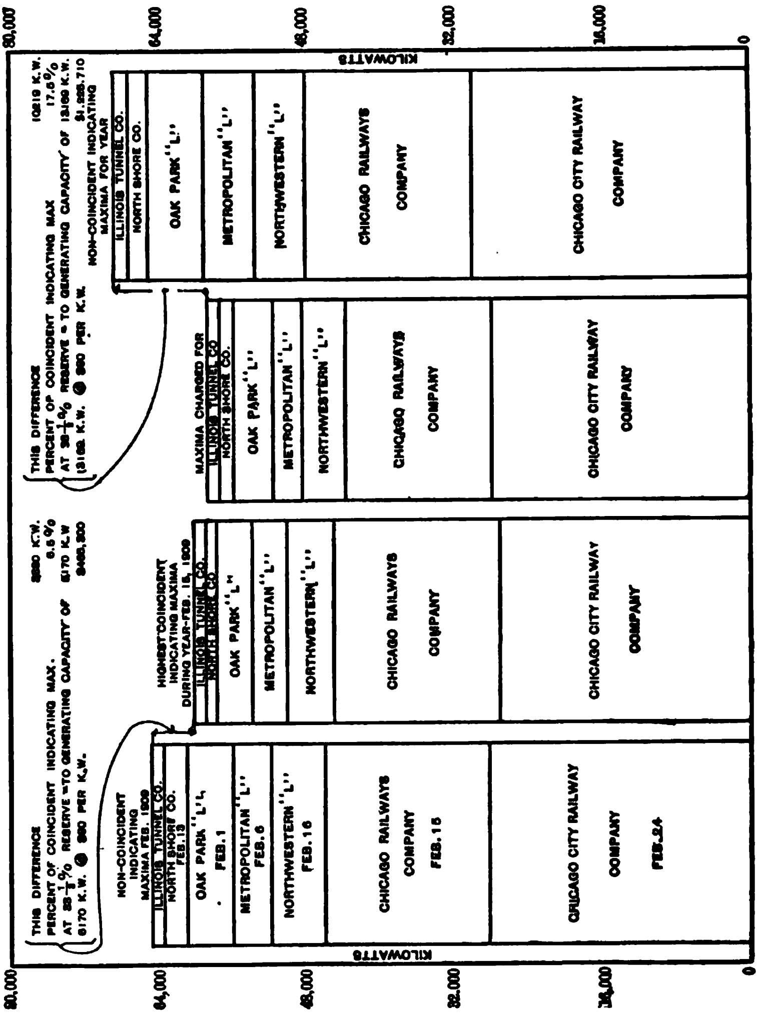


Fig. 6. Actual Conditions of Diversity of Electricity Supply in Chicago in 1909

this way: On February 13 we had the maximum of the North Shore Electric Company, that is a lighting or electric-service company. The maximum of the Oak Park "L" Company came on February 1; that of Metropolitan "L" on February 6, the Northwestern "L" on February 16, the Chicago Railways Company on February 15, and the Chicago City Railway Company on February 24. You see how the diversity factor helps us out there. Of course, if all these concerns were in one company the situation would be different, but taking it as the

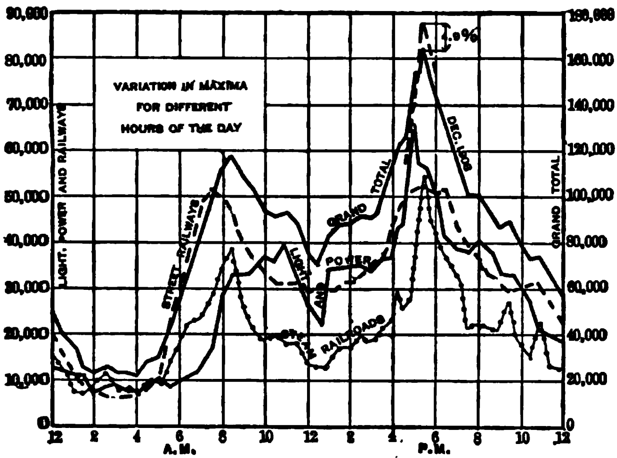


Fig. 7

business exists in Chicago, you will note that not any two of them came on the same day. The maximum railway load of the year was on February 15, on the day that the Chicago Railways Company's maximum came, not, as you would naturally expect, on February 24, the date of the maximum of the Chicago City Railway Company, our largest railway customer.

We sell to the railway companies on the basis of the average maxima for the three highest days, or consecutive highest days of the year, counting the two maxima of the day, namely, the morning maximum and the evening maximum. The re-

sult is that we were paid for about 16 per cent less than they actually took on an indicated maximum; that is, on a swing maximum. That is a very important thing in figuring out this contract, because I have never yet struck a railway engineer who figured it in at all, or pointed it out to me. We always figured the price 16 per cent or 17 per cent higher than it actually was.

The third column of Fig. 6 represents the maxima charged for, and the fourth column represents the non-coincident indicating maxima for the year; that is, the swing maxima for the year. The difference between the two is 17.5 per cent of the coincident indicating maximum. The difference between the non-coincident indicating maxima in February, 1909, and the highest coincident indicating maxima (on February 15, 1909) was 6.5 per cent.[1]

Cost of Producing Energy for Railroads

A rather interesting diagram is that of Fig. 7, showing the variation in maxima for the different hours of the day. Our light-and-power business and our street-railway business are shown. The steam-railroad load curve is that of the New York Central and is added so that we may see the effects of combination. The figures are those of a winter day.

I will leave our figures for a few moments and show you

1. The following table was a part of the original chart of Fig. 6:

(The figures represent kilowatts)

	Maximum Charged for	Non-Coincident 1 Hr. Maxima Feb., 1909	Coincident Indicated Max. Feb. 15, 1909	Non-Coincident Indicated Max. Feb., 1909
Illinois Tunnel Co.	970	1,105	800	1,080
North Shore Electric Co.	1,570	1,770	1,800	2,600
Oak Park "L"	4,520	4,900	4,000	4,800
Metropolitan "L"	3,490	4,350	3,500	4,100
Northwestern "L"	4,317	4,530	5,000	5,400
Total Elevated	12,327	13,780	12,500	14,300
Chicago Railways Co.	15,820	17,060	17,900	17,900
Chicago City Railway Co.	27,744	27,960	27,000	28,000
Total Surface Lines	43,564	45,020	44,900	45,900
Grand Total	58,431	61,675	60,000	63,880

what has been done by some of the steam railroads. The New York Central has an investment of about $6,000,000 in power stations and cables and conduits. I asked for the figures that way, because in selling to the railway companies, while we meter the energy at our generating station, we provide the cable and conduits for conveying the electricity to the railway substations; that is, the street-railway substations. Figuring a fixed charge of 12 per cent, which is not unreasonable (that would be 5 per cent for money, 5 per cent for depreciation, and 2 per cent to cover insurance and taxes), would make a charge of $720,000 a year before ever turning a wheel. That is, before they attempt to produce any electricity it costs them $720,000 a year.

The New York Central has a reasonably low cost of production; incidentally it is more than 50 per cent greater than our secondary rate to the Chicago City Railway Company.

I have been somewhat embarrassed in preparing some of these diagrams, especially Fig. 1, as I did not want to show my costs;[1] but I assure you that we sell electricity on the basis of so much to cover our fixed charges and so much as a selling price per kilowatt-hour. If we quote 0.4 cent per kilowatt-hour we do not expect to quote a price that is lower than our cost. The New York Central people's maxima were based on what they would have to pay us, not based on their indicators; their indicators show 15,000 kilowatts. Incidentally I may remark that they have one station that has not turned a wheel in two years. Their maximum load, based on what they

1. This frank statement is very interesting. As a matter of fact, publication of the Briarcliff speech was suppressed at the time of the convention, and this is its first appearance in print. After the address had been delivered the shorthand reporter's notes and transcript were turned over to Mr. Insull, and the speech was not even published in the official Proceedings of the Association of Edison Illuminating Companies, although this book is circulated only among members of the association. The official report contained this statement: "Mr. Insull then delivered his address, which, at his request, has been omitted from the minutes." Several years later the author of the address was asked why this action was taken, and he answered as follows: "At that time I thought that the charts, figures and data used were of such a confidential nature that it was questionable whether even a private publication should be made. I had not then arrived at the conclusion, as I did later, that the best way to operate this business is to take the public into one's confidence."

would have to pay us, would be 12,700 kilowatts; that is, allowing a 17.5 per cent difference. Their kilowatt-hours generated were 44,000,000 and their cost was around 0.6 cent; consequently their operating cost was somewhere around $275,000. If you take the total fixed charges of 12 per cent and add their cost of production, it shows a total cost of $995,000 a year.

The Pennsylvania Railroad people did a little differently. They employed a firm of consulting engineers who put up a plant for them at a cost of $3,500,000. I do not know whether these figures include cables and conduits; I assume that they do. On the same basis of 12 per cent, they have a fixed charge of $420,000. Their maximum kilowatts happen to be the same, so on our basis of figuring we would reduce the 15,000 kilowatts to 12,700 kilowatts. The kilowatt-hours generated were 30,000,000. This company's operating cost is higher than that of the New York Central.

There is one thing I should say, and that is that the difference in the price of fuel between the East and West should make a substantial difference in the cost of electrical energy — how much I do not know, so I simply had to make a comparison based on our present contract with the street railways.

The total operating and fixed charges of the Pennsylvania Railroad were $630,000, on my basis of figuring, but if you combine the two railroads the figure is $1,625,000. Now, that is the annual electrical-energy expenditure of the two greatest railroad corporations, probably, this side of the Missouri River. If they had bought energy at $15 a kilowatt of maximum demand and 0.4 cent per kilowatt-hour, their total combined expenditure would have been $677,000, or a saving of $948,000 a year.

A Very Satisfactory Class of Business

That statement is not entirely fair. The New York Central Railroad will eventually, no doubt, be able to use its entire generating plant. But who in this room would ever think of building a generating plant and having it stand absolutely

finished and idle for two years after the contractors left the work? That is what results from people going into a line of business which they do not understand. Similar cases may be found in other parts of the United States, and the mistake will be repeated again and again by the steam-railroad companies unless you people in this room put your shoulder to the wheel. If you have not economical plants, provide the capital to put them up, and cater for this class of business, which in my judgment, is lying right at your feet. It is perhaps the most satisfactory business you can get. You deal with very few customers. I think at the present time we have $2,500,000 a year of it on our books. In all we will get $20,000,000 or more, taking the average life of the contracts. You collect your money every month without any question. It is the cheapest revenue for you to collect. You can turn your capital quicker than you can in any other branch of your business. And it is easier to give the utilities satisfaction than the man who takes two or three lamps in an apartment. In addition, you are in a large way of business, producing your supply on a scale of some magnitude; you are manufacturing something that amounts to something. You are starting to get yourselves in a position where you can afford to run your entire small-customer business at a loss, and, gentlemen, you have got to do that eventually, if you expect to remain in the business.

Just dwell for a minute on these figures of the Pennsylvania and New York Central railroads. Look at it from our point of view. We are all of us interested in the general use of electrical energy for all classes of transportation. We hope, if we cannot get the big amount of business, that we can catch on to the outskirts and get a little of it. Just fancy this business being handicapped with a fixed charge in the experimenting days of the business, amounting to interest at 5 per cent on $19,000,000, or an amount large enough, probably, to bring another great trunk line into the city of New York.

I almost took a man's breath away yesterday when I told him that our average income from one of these large railway companies was 0.75 cent a kilowatt-hour last year. But

there is more money in selling that railway company at that price than there is in selling some little customer at 10, 12, or 15 cents a kilowatt-hour. Take column 36 of Fig. 1; that demonstrates the fact. If the actual figures were on there, you would find that the cost of supplying the average residence that uses tungsten lamps is so near the selling price that the difference is hardly worth talking about.

In a way I am not disinterested; I am talking to you with a motive. I am trying to get this class of business in Chicago. I will go anywhere in the United States to help any of you get the same class of business in large units, because the more that class of business is canvassed for and is obtained, the easier it will be for me to build up the control of the manufacture of electrical energy in the community in which I live. That is the interested point of view from which I am talking.

A Colloquy with a Public-Service Commissioner

A gentleman came into my office the other day, connected with the Public Service Commission of New York — I forget whether it was the First or Second District — who is very much interested in the railway proposition. He was sent to me by Mr. Mitten,[1] the president of the Chicago City Railway Company, a man to whom I owe a very great deal for co-operating with me, laying all his cards on the table and showing his costs absolutely openly. Mr. Mitten negotiated with me on the broad basis that he did not want to produce energy, and that I ought to produce it. On the other hand, I did not want to sell it to him unless I could make him a proposition which it would pay him to accept, and that meant, of course, a proposition which would be certainly as low as his costs. This visitor of whom I started to speak wanted some information on the purchase of electricity by the railway company. When he came I had some of the preliminary charts, which I have showed you this evening, lying around, and I showed him what the idea

1. Mr. T. E. Mitten, now (1915) chairman of the executive committee and president of the Philadelphia Rapid Transit Company.

meant. He asked: "Do you mean to tell me that the people can get a lower price if there is a monopoly of all these generating plants?" "Yes," I answered; "that is exactly what I mean to tell you. Our business is run on that theory. At present our highest price is 12 cents a kilowatt-hour to the smallest customer; but any man who burns light two hours a day, any manufacturer who uses more electricity than that equivalent, can buy energy from us at nine cents an hour. And he will buy it at a much lower price in the future." His next question was: "Do you make money?" "No," said I, "we lose money if you take that basis of business by itself." Next he wanted to know: "What are you after?" My response was: "What I am after is getting the lowest possible average cost of production to sell the energy at the lowest possible maximum price." Then he demanded: "What are we to do with the companies in order to get them to do that kind of business?" In turn I asked: "What do you do? Have they done everything you think they ought to do?" He concluded: "If we had the authority, we would try to make them."

"Make Your Securities Good in the Markets of the World"

Just as sure as grass grows and water runs, the people who are running their business on the line suggested by these various charts will supply the experience and compel every one of you to run your business on that basis. It is good for you that they should. Many of you who were present at the Atlantic City meeting of the National Electric Light Association[1] heard Mr. Frank A. Vanderlip, president of the National City Bank of New York, talk on the advantage of raising large sums of money for public-service business, instead of small sums of money — doing business in a large way — and you heard him say that the financiers liked it and investors liked it. I tell you that it has been much easier for me to raise the money to provide for the necessary expenditures of our Chicago company since

1. This convention was held on June 1–4, 1909.

we have been in the business of keeping anywhere from 20,000 kilowatts to 30,000 kilowatts ahead of our demand than it was in the time when I had to raise about one-tenth of the money. It is a much easier proposition. I repeat here what I said at Atlantic City, addressing myself especially to the managers of the small companies: If you are in communities where the business is limited, look out for the next community and get your two properties together; then try to get still another, and so on, until you have an area that will justify you in building large, economical stations. If you do that, when the steam railroads come to consider the question of electrification; when the interurban and urban roads come to consider the question of increasing their energy requirements; when the manufacturers proceed to enlarge their establishments, needing more energy to drive their machinery — then you will be able to quote prices that will give you the business on a basis that will give you a handsome return and make your securities good in the markets of the world.

PRODUCTION AND SALE OF ELECTRICAL ENERGY IN CHICAGO[1]

BEGINNING by saying that Chicago is the market place of the richest producing valley in the world, Mr. Insull remarked that, to assure its continued success and prosperity, not only were men needed — men possessing the characteristics that have made Chicago great — but these men most have at their disposal material advantages which are essential to the industrial, commercial and social life of a great city. Among these advantages the possibility of procuring cheap electrical energy is most important.

All electrical men, whether in the service of the electricity-supply company or in the service of manufacturing corporations or engineers advising their clients, are equally interested in the development of electric service — in the distribution and sale of cheap electricity in the community.

The figures bearing on this business are very interesting. There is about $60,000,000 invested at the present time[2] in the generation and distribution of electrical energy from central stations within the corporate limits of Chicago. One may gain a better idea of what this means when he reflects that to pay 6 per cent interest on the money invested takes about $400 an hour twenty-four hours a day and 365 days in the year. To enjoy the right to earn that interest the company has to pay, and does pay with pleasure, to the city and state an amount in taxes and compensation that exceeds $100 an

1. On October 20, 1909, Mr. Insull was the principal speaker at a luncheon of the Electric Club of Chicago. A large audience of representative electrical men listened with interest to the address. The major portion of a report made at the time for the *Electrical World* is reprinted here.

2. Four years later the bond-and-stock liabilities of the Commonwealth Edison Company were about $78,000,000.

hour. The total amount paid this year in taxes and compensation is about $900,000.[1] It is a common thing for the newspapers in discussing public-service corporations to indulge in criticism relating to the alleged evasion of taxes on the part of these corporations. Mr. Insull asked his hearers to believe in view of the statement he had just made that such criticism did not apply to the company of which he has the honor to be the head.

Statistics of Production and Distribution

It takes an average of more than 100 tons of coal an hour 8,760 hours a year to produce the energy which the Commonwealth Edison Company sells. At certain times in the winter this coal must be burned at the rate of from 200 to 250 tons an hour. "Fancy," said Mr. Insull, "the engineering brainwork that must have been centered in that one proposition — how to get through the grates 250 tons of coal in an hour. To take care of the business, to stand ready to deal with large and small consumers as they come along, we have at the present time a capacity of 240,000 horse-power, and during this coming winter the maximum load on our central stations will be upwards of 200,000 horse-power. I do not know how much electricity is being generated by water-power plants at Niagara Falls, but I think the amount of electrical energy we get from our steam plants here in Chicago will compare favorably with that produced by the great plants at the foot of Lake Erie."

Fifty-four stations and substations are needed to meet the various classes of business, from the smallest lighting installation to the operation of a railway system. These substations have a converting rating of 275,000 horse-power, and the current that passes through them is conveyed by a total mileage of 1,255 miles of cable, 4,000 miles of overhead wires and a conduit mileage of 2,200. This development has taken place in less than thirty years, and in order to take care of the growth of

1. In 1914 almost $1,500,000 was paid in taxes and municipal compensation. Similarly nearly all the statistical figures should be increased to describe present-day conditions.

the business the company is spending about $4,500,000 a year, or nearly $15,000 for every working day of the year. These figures give some idea of the investment side of the electric-service business in Chicago.

Rates Decrease with Increase of Output

Mr. Insull declared that the kilowatt-hours sold between 1896 and 1909 had multiplied forty times, and he said that the extent of the business was now such that the saving of 0.001 of a cent in the manufacture of a kilowatt-hour would amount to about $4,500 a year. Forming a striking comparison with the increase of the business is the decrease in average rates. The company's income for the year 1909 is only 25 per cent per unit sold of the income received in 1896. Of course, the gross income is much larger, but statistics show the decrease of the average rate at which a kilowatt-hour is sold. This marked decrease in rates has been accomplished by improved apparatus, concentration of production and success in selling the greater volume of output.

The Day of the Isolated Plant Has Passed

The speaker referred to the sale of electricity as a monopoly business, and said that an isolated electric plant is as much of an anomoly as an isolated gas plant or an isolated waterworks would be. He contended that the day of the isolated plant has passed, and, whether for supplying electricity to an office building or for the electrification of the terminal of a great railroad, there is no economical justification for the existence of such a plant.

"I wish to dwell upon this point," said Mr. Insull, "for the benefit of those of you who are not engaged in the manufacture of energy. It you will bend your energies to the sale of current-consuming devices, you can build up a business which has a permanency; if you bend your energies to competition with a power-generating company, I do not care in what city

that company may be located, you are in the course of years doomed to failure. It is not among the possibilities in this day that electrical energy can be produced by small units in competition with the large production on a wholesale basis of the generating company."

Mr. Insull made the interesting statement that in looking over the field for his company in Chicago, as near as he could figure, the company is doing only about one-third of the possible business. This does not refer to the future growth of the city, but simply to the possible electricity-supply business in Chicago as it exists today. The speaker then called attention to a map of Chicago showing the generating and substations of the company. Beyond the city limits, too, electricity generated in Commonwealth stations is distributed as far north as Milwaukee on the north and Kankakee on the south, a distance of about 140 miles.

Possibility of Railroad-Terminal Electrification

In closing, Mr. Insull emphasized the fact that the interest of all members of the Electric Club should be as one in extending the use of electricity. The producing company is engaged in an effort to produce the largest amount of electrical energy at the lowest possible selling price. The claim is made for Chicago that it has the lowest selling price of any large electric-supply company in the world. Taking the whole schedule of rates through, it is believed that electricity is sold cheaper in Chicago than anywhere else on either side of the Atlantic where energy is produced from steam-driven stations or even from water-power stations established as commercial propositions to make money. This fact should mean a great deal to those who represent manufacturing companies. If electricity is cheap there is, of course, a greater inducement to use current-consuming devices.

The cheap electricity available in Chicago should have an important bearing upon the agitation in relation to electrifying the terminals of the steam railroads. There are, of course, important problems to be settled before this electrification can

be accomplished, and it is well for all who are not steam-railroad men to treat these problems with respect. But so far as the energy-producing side of the argument is concerned, it is a mistake to say that electrification is impossible because of the cost of electrical energy. If this objection is based on a knowledge of the cost of electrical energy used for the electrification of steam-railroad terminals around New York, it is based on false premises if it is contended that the same cost of electrical energy must apply in Chicago. It is a fact that electrical energy can be bought in Chicago considerably cheaper than it is now being produced by the two great traffic lines which are engaged in electrifying their terminals in New York.

Mr. Insull said that he would be glad to answer any questions put to him, and when the applause following his address had subsided one visitor asked whether in case the railroad companies in Chicago should decide to electrify their terminals, using energy purchased from the Commonwealth Edison Company, it would be necessary for that company to build new generating stations to care for this demand. The answer of Mr. Insull was that his company could take care of any two railroad terminal electrifications in Chicago, based on the present consumption of electricity by the roads running into the New York Central station in New York, with the present rating of the Edison stations. With additional equipment which has been ordered to go into service within a year, two additional terminals of like capacity could be served.

Heating Devices and the Question of Profits

Mr. F. J. Holmes asked how much of a factor in the growth of the business the placing of electric-heating devices on the circuits of the company was proving to be. Mr. Insull answered that this was a difficult question to answer. He spoke of the company's recent flatiron campaign, but said that it would be difficult to trace exactly the amount of load due to electric-heating appliances. The speaker said that some years ago he tried to figure out the effect of fan motors on the business, but

he had to relinquish the idea of getting exact information, as anything like fan motors or electric-heating appliances, that are more or less a matter of general daily use among the 70,000 or 80,000 customers of the company, are difficult to trace as a component part of the total load. Mr. Insull added that he thought the reduction in the rates had had the effect of encouraging the use of heating devices.

Mr. J. W. Mabbs, superintendent of the Board of Trade Building, referred to the reduction in average rates and said that it would be interesting to have a curve of profits to compare with it. To this remark Mr. Insull made answer to the effect that if there were no danger from competition he would be glad to disclose in exact figures the profits of the company, showing the small margin remaining for this purpose.

THIRTY YEARS OF ELECTRICAL DEVELOPMENT—1879–1909[1]

IT IS a very great pleasure to me to look back over the last thirty years. I think it is about thirty-one years ago when one night in November, 1878, I was standing upon a dingy platform of the Metropolitan Underground Railroad of London — a railroad that in my boyhood days we used to call "the Sewer"— waiting for a train to take me to the house of one of the leading editors of one of the London weeklies, into whose service as shorthand writer (or shorthand clerk, as the expression was then in England) I had entered to eke out the small salary I got in the City during the day. My eye happened to rest upon an American magazine at a bookstand, and as I had a ride of some half or three-quarters of an hour before reaching my destination, I bought that magazine. In it I found, merely by accident, a very entertaining article descriptive of the work of a man whose name, although well known in America, was comparatively little known outside of the United States, but a name that today is a household word wherever current literature circulates. I refer to the name of Mr. Thomas A. Edison, the inventor.

At that time we hardly knew of the existence of the telephone. But few in the world knew anything about electric-lighting experiments. The article that I read that night affected my career in a way that I little thought on that occasion,

1. Address delivered at the fourteenth annual meeting and dinner of the Electrical Trades Association of Chicago at the University Club, Chicago, November 12, 1909. This speech is particularly interesting by reason of its autobiographical and historical data. It shows its author's "human interest" in the great industry with which he is identified. A pleasant incident of the dinner was the drinking of Mr. Insull's health, the toast being proposed by Mr. Charles E. Brown, the toastmaster, in honor of Mr. Insull's fiftieth birthday, which fell on the preceding day.

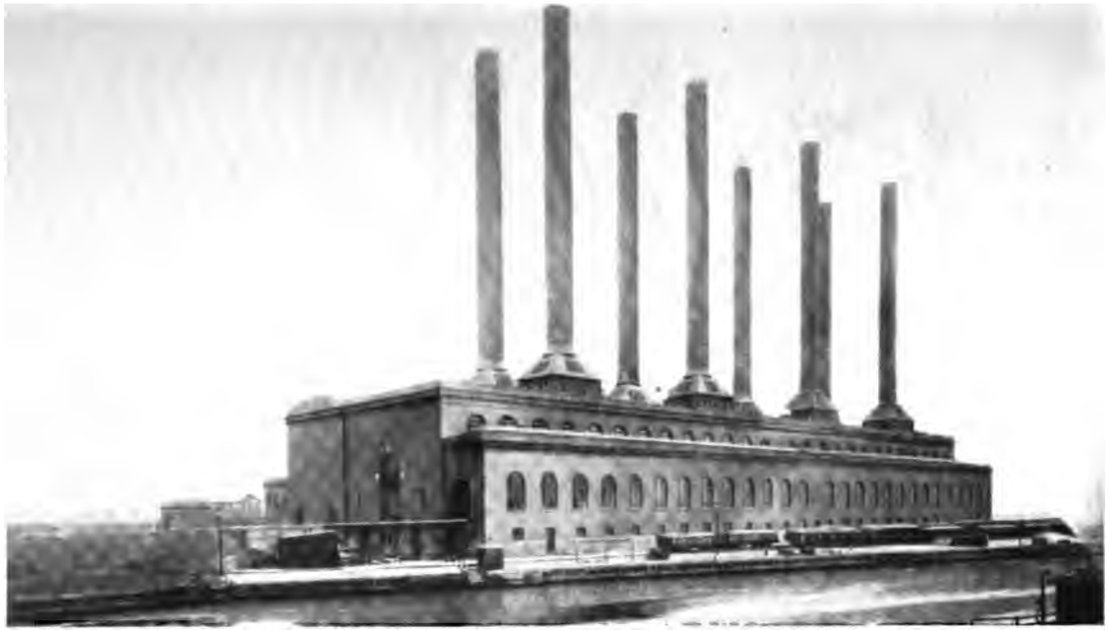
for within three months after that time, by an accident, purely an accident, after being engaged by an American who had an office in Lombard Street in London, I found I was private secretary to Mr. Edison's European agent.

Looking at it today, when every branch of electrical work has been developed to so great an extent, it seems almost impossible to realize that at that time, when I was on the threshold of my career in the electrical business, there was little or nothing in the way of telephone service. (I am now speaking about the time of January, 1879.) There were a few telephone exchanges in this country. My friend Mr. Sunny,[1] who entered the service of the Chicago Telephone Company in May, 1879, informs me that probably there were two or three exchanges in Chicago. We find that the record shows that the first one was opened in New Haven some time during the previous year, 1878; but you could not find anywhere outside of the United States in the spring of 1879 a telephone exchange. The first one erected in London was, I think, put in service some time in the fall of 1879, and it was my privilege to operate it for the first half-hour that it was in operation.

If you go a little farther back than thirty years ago, you will find that the only source of electrical energy was the voltaic battery, and it is not until early in the seventies that you can discover anything in the records descriptive of the dynamo as a producer of electricity, such as we know it today. Little or nothing at that time had been accomplished in connection with electric lighting. In Europe some work had been done by Werner von Siemens and some of his associates, and there was a distinguished Russian engineer by the name of Jablochkoff who had produced what was known as the Jablochkoff candle, a form of arc lamp which was exhibited on the Avenue de l'Opera in Paris in 1878, and a few months later on the Thames Embankment and Waterloo Bridge in London.

Mr. Jablochkoff's efforts, although of great consequence in the development of the art, outlived his first experiments only

1. Mr. Bernard E. Sunny, president of the Chicago Telephone Company and several other telephone companies (1915).



Quarry Street Generating Station of the Commonwealth Edison Company, Chicago, on the South Branch of the Chicago River

a very few years, and I think never amounted to anything in this country except that in 1881 a few lamps were put on exhibition by my lamented friend, Mr. Charles Cheever, who made quite a reputation in connection with the early introduction of the telephone.

The Invention of the Telephone

We have to go back to the Philadelphia Centennial Exposition of 1876, where Alexander Graham Bell first exhibited an instrument that carried the utterances of the human voice imperfectly over a wire by means of electricity. I have an old friend in New York who has been in the electrical business a few years longer than I have myself, and who tells me that he visited the Centennial Exposition and saw the first exhibition of the telephone, when Dom Pedro of Brazil was visiting the exposition. There are some enthusiastic admirers of Mr. Edison who declare that they saw experimental instruments in use at Menlo Park a little prior to that, which gave as much in the way of conversation as the work of Mr. Bell.

I think, and I have no doubt that all in this room think, that the credit for the invention of the telephone must be given to Alexander Graham Bell, just as I think that the credit for the invention of the carbon transmitter that we all use today, whatever may be the claims of other inventors, must be given to Thomas A. Edison.

Electrical Supply Dealers of Thirty Years Ago

Take your own line of business. What was its situation thirty years ago? There was little or nothing known of an electrical supply organization. The only material to be sold was material for telegraphic work and house-bell work. There were three supply houses in New York — Tillotson's, Bunnell's and that of Charles T. Chester. The Western Electric Company, whose headquarters as you all know are in this city, had a branch at that time in Church Street, New York, and it did more or less of a supply business.

At that time the greater part of the supply business was done by mail on special orders, and about the only concerns I can find any record of were Partrick & Carter of Philadelphia, Watts of Baltimore, Buell of Cleveland, and Charles Williams, Jr., of Boston, who was afterward taken into the Western Electric Company. I believe my old friend, Mr. E. T. Gilliland, also did more or less of a supply business in Indianapolis. But what we know as the electrical supply business as we have it today had practically no existence then.

I can remember when I arrived in New York in 1881, Tillotson's and Bunnell's (I think the latter was J. H. Bunnell & Company and I think the style of Tillotson's concern was Tillotson & Sons) had establishments somewhere in the neighborhood of the then and present Western Union Building, on the side streets near 195 Broadway. If you went into their stores, you found that they resembled more a storehouse of one of the big iron-wire concerns than what we would consider an electrical supply store. The business was of little or no consequence, and in contrasting the situation as it existed then and as it exists now we are forced to the conclusion that the business in which we are all engaged is really a product of the last quarter of a century.

Take the situation of the telegraph and cable lines. If you wanted to send a message from New York to London at that time, my recollection is it cost a dollar a word. I was more familiar with it from the other end of the line, however, and it used to cost us four shillings a word.

Take the telegraph tolls in the United States. Mr. Sunny informed me today that the telegraph rate between New York and Chicago thirty years ago was $1.15 for ten words, and the rate between New York and San Francisco was five dollars for ten words.

Thirty years ago we were on the threshold of enormous industrial changes the world over, and the greatest of those industrial changes have been changes that have brought us the telephone, the electric light, the electrical transmission of power, the electric railway, the wireless telegraph and the hun-

dred and one small things that have followed in the wake of these various enterprises.

The Beginnings in Electric Lighting

In 1879 the only electric-light service that anything was known about in this country was the work of Mr. Brush, of Cleveland, Elihu Thomson, Professor Houston and a few others who were engaged in series arc-light business.

Mr. Edison's work on incandescent lighting was just being talked about. I think it was in December, 1878, that it was first discussed in the public press. This discussion was followed by a rather sensational drop in the price of gas shares the world over; but it was not until about a year later, in 1879. that Mr. Edison made his first exhibition at Menlo Park of his paper carbon lamp, and it was not until the summer of 1880 that any of those experimental lamps found their way outside of the laboratory. It was my privilege in August, 1880, to see one of Mr. Edison's first lamps lighted up to a dull red in the basement of a building in Queen Victoria Street, London, the energy for lighting the lamp being supplied by about forty cells of Grove battery.

When I came to this country on the first day of March, 1881,[1] the discussion in the public press with relation to electrical matters turned on whether Edison, to use a popular expression of that day, had succeeded in subdividing the electric light, or whether the claims that he made of success in that direction were simply the vaporings of a wild imagination. There were very few people on either side of the Atlantic who had any belief whatever in what had been accomplished up to that time.

Notwithstanding the fact that there was a complete system of underground distribution — I should say a complete two-wire system of underground distribution — fed by feeders from a central point, and that that system was operating lamps and motors in multiple out at Menlo Park, there were, as I

1. This should be February 28, 1881. See note on page xxvi.

say, very few people who had the slightest belief in the commercial value of Mr. Edison's work.

On the second night that I was in this country, I was taken out to Menlo Park by Mr. Edison. We arrived there about nine o'clock in the evening, and I well remember how surprised I was to see the fields around his laboratory, the houses of himself and his assistants, all illuminated by this wonderful new light, using a carbon-filament lamp — a decided improvement on the paper-filament lamp which I had seen in London. I recall that I was quite impatient on that occasion to run down to the railroad station from the laboratory, about half a mile away, to send a cable to my friends in London, telling them that I had seen Edison's system in operation. About ten or twelve days later I received an acknowledgment from the man to whom I cabled, a man who is now the representative of the Western Electric Company in London, in which he said he supposed I had been in America just about long enough to be able to draw the long-bow as well as any of those Yankees with whom I had been associating.

It is a matter of very great interest to those of you who follow the engineering side of this business to know that this first exhibition of Edison's electric lighting system at Menlo Park obtained its power partly from a direct-connected unit, composed of a dynamo of Mr. Edison's design, and an engine manufactured by Mr. Charles T. Porter, the engine being of the type commonly known throughout the country as the Porter-Allen engine. I think it was possibly about 60 horse-power, and my recollection is that it ran somewhere between five and six hundred revolutions per minute.

It is rather remarkable that the first engineering effort in connection with the development of the great industry which goes such a long way toward supporting practically all of the businesses represented in this room, outside of the telephone interest, should have been so correct as to be composed of a class of apparatus that we all went back to a quarter of a century afterwards. I think this fact is one of the greatest tributes to Mr. Edison's engineering ability.

The Starting of Central Stations

You must excuse me if, in reviewing electrical progress during the last thirty years, I mention the name of Mr. Edison so frequently; but as I understand electrical development, it is impossible for me to do otherwise. If you will study the records of the United States Patent Office, you will be forced to the conclusion that at least from one-half to three-quarters of the electrical development which we enjoy at the present time can be traced fundamentally to the great intellect, the great genius, of the man under whose name it has been my privilege to work for thirty years.

It was not until 1882 that the first central station for incandescent lighting was put in operation in New York city. At that time the telephone business had attained considerable proportions. The old fight in this country between the Bell interests as represented by the American Bell Telephone Company, and the Edison interests as represented by the Western Union Telegraph Company, had been settled, and the entire telephone business was operated then, as it is largely now, as a monopoly business.

About the same time that the central-station electric-lighting plant was started in New York on Pearl Street, just south of Fulton Street, there was a small plant started at Appleton, Wisconsin. I think, largely on account of its small size and the ease with which the smaller apparatus could be produced, the chances are that the Appleton plant started before the New York plant, and therefore the Central West probably can lay claim to the honor of starting the first commercial incandescent-lighting distribution system in the world.

There had been various efforts made in Europe, but they were mainly in the direction of series lamps; that is, lamps of low resistance run in series. But all systems of that character have long since disappeared as being uncommercial, and the only system in existence the world over today is the multiple-arc system, using high-resistance illuminants.

Soon after the starting of the New York and Appleton

plants there were plants started in London, but only for exhibition purposes. There were plants started about that time in Santiago, Chile, and in Milan, Italy.

Various Steps in the March of Progress

To go back to 1879: The first miniature electric railway carrying passengers was put in operation at the Berlin Exposition, by Siemens & Halske, in that year. It was purely an exhibition plant, and it was not until two years later that any commercial road was put into operation in Europe, and that was a small one outside of Berlin, a mile and a half long. Not long after (in 1883, to be exact) there was a similar exhibition here, in Chicago, on the Lake Front, in the old Exposition Building where the Art Institute now stands. There may be some in this room who remember it. It was a little circular railroad, not to carry passengers but just a toy railroad, which operated, I think, one car.

Electrical events came in rapid succession; but it is an interesting thing to note that it was not until 1881 that there was any official definition of any of the electrical units, and it was at the Paris Electrical Congress of 1881 that the ohm, the volt and the ampere were first authoritatively defined as the basis for legislative action in the various countries.

It was in this same year that a "box of electrical energy," what we call the storage battery of today, was carried from Paris to Glasgow by Sir William Thomson, afterward Lord Kelvin. It was one of the early storage batteries, and was made by Camille Faure. The unique demonstration attracted a great deal of attention at that time, but it was years afterward before the Faure cells came into general use.

At the Paris Exposition of 1881 was the first demonstration of a direct-connected dynamo and engine outside of Menlo Park. I had the privilege of having a great deal to do with the manufacture of that first unit in New York and its shipment to Paris. Mr. Edison's exhibit in Paris of that unit was made by Mr. Charles Batchelor, one of his earliest assistants.

Between 1882 and 1886 the alternating system supplemented the direct system and came into general use, and some time during that same period the three-wire system of Edison was put into use. By this great improvement in wiring the amount of copper necessary for the direct-current system was cut down so that we got along with about 40 per cent of the copper originally required.

The introduction of the alternating system and the Edison three-wire system gave a tremendous impetus to the electric-lighting business. It was but a very few years before the electric-lighting business assumed proportions rivaling those of the telephone industry, and we began to see the springing up all over the United States of establishments for the sale of apparatus. From my own personal experience, and much to my own cost, I can assure you that at that time we needed a credit association very badly indeed.

The electric welding of Elihu Thomson was first brought out in 1886.

The first serious efforts at electric-railway work in this country were made in 1888. Some years earlier, in 1880, Mr. Edison had built an experimental road at Menlo Park, and Mr. Stephen D. Field had done considerable work in connection with electric railways; but it was not until 1888 that Mr. Frank J. Sprague's first electric road was started at Richmond, Virginia. We have in this city at least two men who were engaged on that work—Mr. A. D. Lundy, of the firm of Sargent & Lundy, and Mr. Frank J. Baker, the vice-president of the North Shore Electric Company.[1]

Central Stations and Power Transmission

In that same year, 1888, the first central station was established in the city of Chicago. At that time there were a large number of isolated plants, in fact I think more in Cook County, in proportion to population, than in any other part of the United

1. Later the North Shore Electric Company was merged in the Public Service Company of Northern Illinois, of which Mr. Insull is (1915) president and Mr. Baker one of the vice-presidents.

States, but no efforts had been made in the direction of central-station work here until some time in 1887, when the Chicago Edison Company was formed. It was in 1888 that the first Edison central-station plant in Chicago was started at 139 Adams Street.[1] When I came to Chicago in July, 1892, I think that the plant had arrived at the enormous proportions of somewhere between three and four thousand horse-power. I think they used to try to run a little more than that, but that was about our limit at that time.

It was in 1888 also that Mr. Nikola Tesla contributed very materially to the development of the alternating side of the business. His polyphase-current patents, which forms the basis largely of the alternating dynamos and motors of today, were taken out at this time.

Probably the Paris Exposition of 1889 was the milestone which signalized the great progress of the electric-lighting art the world over. At that exposition, or rather at a congress held at the time of that exposition, we first heard of the watt. It was authoritatively defined by the International Electrical Congress of that year, and what today is a household word with all the people who have to pay for electricity on a meter basis — the much-discussed "kilowatt"—has grown out of the definition established by the authorities at the Congress of 1889.

The first electric-power transmission dates from 1890. There was a system laid out in a small town in Colorado, at one of the mines in that state.[2]

The progress of the electric-lighting art was signalized further by the Chicago World's Fair of 1893. That was, above everything else, an electrical display. We find that there they went back to the direct-connected dynamos, using marine types of engines for the purpose. Two of those engines which were shown at the World's Fair are still (1909) in use at the Harrison Street station of the Commonwealth Edison Company.

1. Now 120 West Adams Street. See note on page 319.

2. The famous Lauffen-Frankfort experimental transmission in Germany was also accomplished in 1890.

X-rays were discovered by Roentgen in 1895, and in the same year Marconi effected communication by wireless telegraphy in Italy for the first time.

The Steam Turbine and What Came After It

Since then we have had the most wonderful progress. We have had the steam turbine, the first large unit being started in this city in 1903. I refer to the steam turbine of American manufacture. Prime movers of this type had been made with more or less success in different parts of Europe, and especially in England, a number of years before the year mentioned; but the large use, or rather the use of large units as we understand them in the central stations of today, where we use units running up to as high as 22,000 horse-power, dates as recently as October 2, 1903, when the first unit was started in the Fisk Street station of the Commonwealth Edison Company, Chicago.

I have tried to survey as rapidly as I could the development that has taken place in this wonderful industry with which we are all connected, in the short space of thirty years — a little over a quarter of a century, a period which is covered by the years of most of us in this room, simply dating from our boyhood days, when we were able to read and understand what was going on in the world.

Some of the figures of the investments in this business are simply stupendous. In this city of Chicago alone there is probably invested in electric lighting, telephones, the electric portion of the street railways and the elevated railways, and the isolated electric lighting plants throughout the city, a sum which must exceed $500,000,000.

Just imagine for a moment what that means. Here we are, engaged in a business that a little over thirty years ago was never dreamed of, and today we have as customers of the concerns which are represented in this room, businesses that employ a capital of $500,000,000. The figures are simply stupendous.

There are at the present time 6,100,000 telephones in use in

the United States, and the amount invested in exchanges and the lines connecting same is upwards of $550,000,000.

There is a track mileage of electric and interurban railways of 40,247 miles, using 89,216 cars, and representing capital liabilities of $4,557,000,000. Of course, these figures represent capital liabilities, and probably some of that capitalization is water; but I personally would very much doubt if the capital invested in electric street and interurban railways at the present time, that is the cash capital, the actual dollars put in, is less than $3,000,000,000.

To turn again to electric-lighting investments. There are about 6,000 central stations in the United States today. Of this number upwards of 3,000 of the companies engaged in central-station work are also in the electrical supply business—a business that twenty-five or thirty years ago had perhaps half a dozen representatives.

The central-station companies of the country have an investment of $1,250,000,000. They have a gross income of more than $250,000,000 a year, and they develop somewhere between 2,000,000 and 2,500,000 horse-power.

The total investment engaged in the three departments of the business on which you gentlemen in this room depend for your business exceeds the sum of $6,000,000,000. That entire business has been created, first, by the wonderful success of the electrical inventors of this country, who have had no rivals in what they have been able to accomplish anywhere on this earth; second, by the wonderful confidence of the capitalists of the country in the ability of those inventors to produce that which would be commercially successful; and, third, by the adaptability of the people of this country to seize upon new things which are conducive either to their comfort or to the economy of their manufacture or to the improvement of their means of communication and transportation.

I think, gentlemen, we can all congratulate ourselves, first, in being privileged to take part in this remarkable business, and second, in being located in a country where whatever new things may come along, if they are things which recommend them-

selves alike to the capitalists who provide the money and the users who provide the revenue from day to day, are promptly adopted. All I can hope is that the success of the last thirty years is only an indication of the great advances that all of us hope, and many of us believe, are likely to take place in this wonderful electrical business, in which we are all so proud to be engaged.

"SELL YOUR PRODUCT AT A PRICE WHICH WILL ENABLE YOU TO GET A MONOPOLY"[1]

WE DO NOT do the largest business in the world, but I think we have the largest output. Probably the company that comes next to us is the New York Edison Company, and the next to that is the one in Berlin, Germany. The New York Edison Company has an income of about $15,000,000 and about 70,000 customers. We have an income of about $10,000,000 and about 100,000 customers. In our experience the most effective way of getting business is through newspaper advertising.

Our average income from our customers is about 2.5 cents per kilowatt-hour. We have customers who take from us 1,000,000 to 1,500,000 kilowatt-hours a year, and there are customers who buy from us as low as 0.75 cent per kilowatt-hour, metered at our station switchboard. The lesson to draw from this is that if you want the best possible results from the manufacture and distribution of electrical energy you have got to sell your product at a price which will enable you to get a monopoly. I am not speaking now merely as the president of the Commonwealth Edison Company. I operate plants in different parts of the country as small as any of those represented in this room. If you will bring your price down to a point where you can compel the manufacturer to shut down his private plant because he will save money by doing so; if

1. The initial convention of H. M. Byllesby & Company and affiliated companies was held in Chicago on January 5–7, 1910. Mr. Insull addressed the convention briefly on January 6, and a portion of his remarks is given. In introducing him, Mr. Byllesby referred to the Commonwealth Edison Company as "the largest manufacturing concern of its kind in the world." Hence the opening sentences in the text.

you can compel the street railway to shut down its generating plant; if you can compel the city waterworks, whether privately or publicly owned, to shut down its power plant because of the price you quote — then you will begin to realize the possibilities of this business, and these possibilities may exceed your wildest dreams.

A short time ago a friend of mine drew for me a series of circles which showed me that the entire steam-railroad system of the country east of Chicago could be operated better and more economically by taking advantage of the centers of electrical production than the railroads could possibly do if, in electrifying their roads, they produced the requisite energy in individual plants.

Look to make your money out of the large business. What is large here in Chicago may be beyond, perhaps, what you can get in most of the communities that are represented in this room this afternoon. Nevertheless, I am sure that if you will follow the methods that we follow here, applying them to the conditions of the place in which you live, you will assist in creating a class of securities that will stand well in the markets of the world. That is the only way that we can expect that eventually this electric-service business will be brought to the success which it deserves.

THE OBLIGATIONS OF MONOPOLY MUST BE ACCEPTED[1]

IT WAS my great privilege to be associated with Mr. Edison in the earliest commercial work that he undertook in New York City, and only a month or so after I had joined his forces, our honored host of this evening joined the engineering department of the old Edison parent company, which was the pioneer in the development of the incandescent-lighting industry.

When we bear in mind what has been accomplished in the short time since the first central station was established in New York in 1882, and when we remember that the original money invested by the Edison Electric Illuminating Company of New York earned dividends for its stockholders without any additional capital being supplied to bolster up that originally put in, we can, with understanding, appreciate the strength and stability of the industry with which we are connected, and the great possibilities which must come to it in the future, if we give it that same attention in regard to details and developments which those connected with the industry have given us in the past.

Mr. Byllesby has occupied in this industry by no means a minor position. I think, probably, on the commercial side of the business, he is as much entitled to credit as any one man in the development of the alternating system which has done so much in enabling us to establish large generating plants, giving us the opportunity for great economy of production, and estab-

1. A speech made on January 7, 1910, at the dinner at the Congress Hotel, Chicago, following the first convention of H. M. Byllesby & Company and affiliated companies. Mr. Byllesby was toastmaster, and he referred to Mr. Insull, in his introduction, as "the largest producer of electricity in the United States." The report of Mr. Insull's speech has been slightly condensed.

lishing large distributing systems, which have added so much to the possible profits of this business.

Regulation, Both as to Rates and Issuing of Securities, Must be Accepted

Our friend, Mr. Dawes,[1] has referred to the tendency of the times so far as legislation is concerned. While as an abstract proposition I think it is very laudable for us to cheer the idea that we should go out and fight any curtailment of our liberty of action, as suggested by Mr. Dawes, yet, as a practical, everyday proposition, and as a necessity, we have to face the views of the various communities of the states in which we are engaged. We should bear in mind, above everything else in the operation of our business, that we cannot afford to place ourselves in opposition to public opinion. If we are to maintain values of the securities for which we are responsible, and to increase those values, we should rather bend our energies to find some means of operating our business to meet the conditions that will undoubtedly confront us in most of the states, certainly the states in the Mississippi Valley.

I think it was some twelve years ago that I first tried to voice the idea that our business is a natural monopoly and that we must accept, with that advantage, the obligation which naturally follows, namely, regulation.

For my own part, I cannot see how we can expect to obtain from the communities in which we operate, or from the state having control over those communities, certain privileges so far as a monopoly is concerned, and at the same time contend against regulation. Further, I think that regulation of the price of our product must be followed by regulation as to the issuance of securities, because our price must depend upon the fixed charges we have to pay; and I cannot see how those fixed charges can be kept down within proper limits unless the authorities, in some way, either the community or the state,

1. Mr. Charles G. Dawes, president of the Central Trust Company of Illinois.

have the right to state the terms on which these securities shall be issued.

I am not proposing to get into a controversy with Mr. Dawes on this subject, but I think we will greatly strengthen our position, and greatly strengthen the securities issued against our business, if we accept the inevitable, and instead of trying to oppose the handwriting on the wall, try, rather, to direct the tendency so indicated toward getting legislation which will enable us to conduct our business in a way satisfactory to ourselves and a way satisfactory to the public.

The Value of Franchises

The franchise proposition has never seemed to be a really serious one to me. My great trouble has always been to get the money for further development. If I managed to get the money, I always found I could live under any franchise given by any fair-minded community. We have had an instructive experience in the last few years in this community in relation to franchises and, indirectly, in relation to the matter of capitalization. We have had here two great street-railway companies. One was supposed to be run very conservatively, so that for every dollar of stock issued the actual cash was paid in. That particular company was looked upon as the bulwark of conservatism. On the other hand, we had another large company, doing double the business of the so-called conservative company, capitalized on a very extravagant basis. Now, the franchises of the two companies ran out. What did we find when those franchises expired? We found this so-called ultra-conservative company, which had never issued a share of stock without having the actual money paid in for the shares issued at par — we found that that company, which was supposed to have been operated in such a conservative way, had for a long period of years not allowed a single cent for depreciation. When it became necessary to put a value on its property for the purpose of arriving at a new franchise arrangement with the city of Chicago, the value placed was below that of the issues of the securities of the company.

Take the other company, where the financing was of a more balloon-like character, where the manager should have been in the water business instead of the street-railway business. Take also the suburban companies, to which Mr. Dawes has referred. We found that those companies had securities outstanding out of proportion to the cash investment. The people who held those securities were laboring under a misapprehension as to the real value of the franchises. As a result, Chicago has got rather a bad name on the subject of issuing franchises, whereas our authorities should have obtained the commendation of everybody interested in the business when they granted to the street-railway corporations franchises, because these franchises practically settle for all time the street-railway question in this community.

I had not intended to speak on this subject at all, but we cannot afford to oppose public opinion, and I think the best course we can pursue, if we want to help the properties in which we are interested, is to find the protection we want in the way of monopoly, giving way to the demand of regulation, but demanding in return a fair regulation and a fair valuation, which I believe we can get if we show to the people the value of the brains we have put into the business, which brains we have as much right to capitalize as the actual cash put in. As far as I have been able to find, companies operating in states where there is regulation, such as Wisconsin and New York, which are two of the most recent examples where there is a state-regulation law — I say, so far as I have been able to find, the companies who have had to appeal to those state commissioners have enhanced the securities of the properties which they have outstanding, provided those securities recommend themselves as reasonable in amount.

The Way to Build Up the Business

I thought it might be interesting to some of you people to know what we are doing here in Chicago in the development of our business. It was only as recently as 1888 that the first central station was started here in Chicago. In 1892 we had

4,000 horse-power, with a capital investment of $1,000,000, and a gross business of $375,000 a year. At the present time, we have power stations with 300,000 horse-power, and a capital investment of $60,000,000 in our business, as shown by a valuation made by my friend, Mr. Byllesby. Our total business is more than $12,000,000 a year. We supply energy to all the street railways. We cover a territory of 65 miles along the shore of Lake Michigan and stretching inland for 2,500 square miles, an area double that of Rhode Island, and having a population as great as the state of New Jersey or the state of Wisconsin. We are aiming here, through three different companies co-operating together, for a centralization or production of electrical energy, and look forward to covering a territory having a population of five million within our distribution area and supplied by one set of generating plants.

As I look around this room and see the names on the various flags representing the various communities in which H. M. Byllesby & Company are operating, naturally the thought occurs to me what are the possibilities surrounding the territory in which you now do business? There is no reason why you should not do relatively in the smaller communities exactly what we do in this large community and the territory surrounding it.

The surest way to build up your business and to serve your community — and you can only serve it satisfactorily if you reduce your rates to a minimum — the surest way you can add to the stability of the local companies that go to make up the strength of H. M. Byllesby & Company is to do everything you can to bring down the cost of production in your generating stations and so to serve the public as to obtain and retain its good will. Do not run counter to the prejudices and opinions of the people, and keep out of politics all you possibly can.

PRESENTATION OF THE EDISON MEDAL TO ELIHU THOMSON[1]

IT IS with peculiar pleasure that I rise on this occasion. A few of us, several years ago on the occasion when the Institute entertained Mr. Edison to celebrate the twenty-fifth anniversary of the introduction of his incandescent lighting system,[2] thought that it would be well to perpetuate his name, if such a thing seemed at all necessary, by presenting the Association with a fund to enable it to make an annual presentation of a medal and certificate of meritorious achievement in electrical engineering. That the first recipient of the medal should be your honored guest of this evening has seemed to us peculiarly appropriate, for Professor Thomson, by reason of his commanding ability and of his lovable personality, has in recent years endeared himself to what might be called the "Old Edison Guard" just in the same way as he endeared himself to our former opponents in business, the gentlemen connected with the Thomson-Houston Electric Company. We who organized the Edison Medal Association feel deeply grateful to your committee that the honor to be conferred this evening should fall to the lot of Elihu Thomson.

When our genial toastmaster asked me two weeks ago if I would speak to the toast "Meritorious Achievements in Elec-

1. An address delivered at the annual dinner of the American Institute of Electrical Engineers in New York city on February 24, 1910, on which occasion the parchment certificate constituting the official notice of the award of the Edison gold medal was presented to Dr. Elihu Thomson, of Swampscott, Mass. As an ardent admirer of Edison, Mr. Insull was much interested in the bestowal of the Edison medal on this and other occasions. He tells something of the history of the medal in his speech. It may be added that Dr. Thomson was given the medal "For Meritorious Achievement in Electrical Engineering and Arts, as Exemplified in his Contributions Thereto during the Past Thirty Years."

2. This was in 1904.

trical Engineering," I began to delve into the past ages, and found myself carried back several centuries before the Christian era. I was preparing to occupy your attention for the whole evening, when he very kindly switched me off to deal with the subject of "Meritorious Achievements in Electricity," and intimated to me that I had better get through with it in about ten or fifteen minutes. So, instead of carrying you from a period five or six hundred years before the Christian era down to Sir Isaac Newton and the inventions of Benjamin Franklin and all the other brilliant lights who have contributed so much to the pioneer work in connection with our great profession, I found myself cut off from delving in the records of the past, and had presented to me the necessity of confining my remarks, in the few moments at my disposal, to what has really taken place in what we might call the present day.

When we remember that the first telegraph was put in operation between Paddington in the West End of London, and Leyton, a small town in Middlesex, in what we Englishmen like to call the third year of the Victorian Era, and when we recall the fact that only a few years later the efforts made by Morse and Vail resulted in the establishment of a telegraphic line between Washington and Baltimore,[1] we must realize that the meritorious achievements in electrical engineering are practically modern-day affairs.

The work in connection with the telegraph might well be called the first great achievement in electrical engineering. The path of electrical investigation and discovery has been followed by a long list of brilliant men. Unless, as I am reminded by Professor Thomson, we recall the work of Benjamin Franklin in connection with lightning rods, the first real work was the establishment of the telegraphic system which has brought about such tremendous changes in the matter of intercommunication between all parts of the world. The overland systems of telegraphy were followed a comparatively few years later by the establishment of the under-sea communication.

1. It was in 1844 that the historic message, "What hath God wrought," was sent over the wire.

I think the first cable of any consequence to be laid was one between Dover and Ostend, in the North Sea, and which I think was put in operation in the year 1850 or 1852. This effort was followed by the formation of the first cable company by Cyrus W. Field and Peter Cooper in this city of New York. It was not until 1866 that the efforts to connect Europe by cable with this vast continent were finally successful.

The next great step in connection with electrical engineering was the invention of the telephone. I think it was in 1874 that Alexander Graham Bell started his experiments which resulted in the exhibition of his telephone at the Philadelphia Centennial Exposition in the year 1876. The first telephone exchange was established in the city of New Haven, I believe, in 1878, and the first telephone exchange erected outside of the United States was installed by my friend Mr. Edward H. Johnson, in London, and I had the honor of operating it, in 1879, for the first ten or fifteen minutes of its existence.

The next step in the development of this marvelous art was probably the work in connection with series arc lighting. Jablochkoff, with his exhibition of his lamps on the Avenue de l'Opera in Paris in 1878, and in London in the early part of 1879, and Brush, Thomson and Houston in this country, marked the next step forward in the development of our industry.[1]

The work of these gentlemen was followed in the years 1879 and 1880 by the introduction, experimentally, of the Edison incandescent lighting system. Mr. Edison's work in this direction was followed very rapidly by the alternating-current system produced by Zipernowsky, and by such men as Bradley, Tesla, Stanley, and numerous others, including our guest of this evening, in this country. In passing I may say that it is well to remember that the one name in this country that will probably stand out foremost in connection with the

1. It may be noticed that in this brief sketch of electrical development there is no mention of the electric railway. This, Mr. Insull has declared since, was due to a trick of the memory. Not until he resumed his seat did he realize this oversight and the lack of mention of the work of Mr. Frank J. Sprague and others in relation to electric motors and the electric railway.

development of the alternating-current system, which has done so much to enable us to produce electrical energy on a large scale at low cost, is that of Mr. George Westinghouse, who has contributed so much else to the progress of the country.

There are a great many other branches of the work that I might refer to — the storage battery, the wireless telegraph, the work of Mr. Tesla in connection with alternating-current apparatus, the work of Lord Kelvin and Dr. Weston, in connection with instruments of precision, and the still later development of the turbo-generator, which has augmented to such a great extent the value of the alternating-current system. We might go on and speculate as to the possibilities of the future, as to whether some member of this Institute may at some future time receive this medal for brilliant achievement in making a more direct cut to get at electrical energy, probably obtaining it from some mineral or some electro-chemical process. But the time at my disposal has about expired, gentlemen, and all I am able to do is to conclude by thanking you for your close attention and by expressing the hope that all those who receive this medal in the future may deserve it as richly as the gentleman who is to receive it tonight.

MASSING OF ENERGY PRODUCTION AN ECONOMIC NECESSITY[1]

COMING to the home of American manufacturing I feel some diffidence in addressing you on the subject of the possibilities of that manufacturing business in which we are all engaged. Low cost of production, the very best of product, eminence in selling — all these have contributed to the conspicuous success of the New England manufacturers during the last fifty years. To attempt to advise you, brought up amid so many examples of economical manufacture, on the question of the possibilities of our manufacturing plant, seems to me somewhat of a dangerous experiment. What we central-station managers want always to bear in mind, above everything else, is that if we expect success in our business the first thing we have to do is to produce the kilowatt economically; the next thing is to learn how to sell it so as to bring the biggest possible return on the dollar invested in the plant for the purposes of manufacture.

We are engaged in a business requiring very large capital in proportion to our annual turnover. The very best result that can be obtained from capital invested in central-station business is to turn that capital about once in five years; I think the average result is to get a return on that capital once in seven years. To put it another way, if you have an income of $50,000 a year, it takes, under the very best circumstances, a capital of not less than $250,000 to operate that business, or under average circumstances a capital of about $350,000.

1. The General Electric Company gave a dinner on February 25, 1910, at the Brunswick Hotel, Boston, to the central-station representatives of New England. Mr. Insull was one of the speakers and made the address printed here.

The manufacture of gas and the distribution of water are also characterized by the slow turning of capital.

Take, for instance, our small customers. In this chart[1] there is represented a block in a residence district of Chicago which has 193 apartments in it. We have in that block 189 customers, and the number of lamps per customer is between ten and eleven. The kilowatt-hours used per year are 33,000. If you take the customers' separate maxima, amounting to 68.5 kilowatts, you will find that the load factor is only 5.5 per cent. All of you know full well that if your entire plant is only in use 5.5 per cent of the time it is only a question of time when you will be in the hands of a receiver. But if you take the maximum at the transformers you will find that the maxima of the various customers comes at such different times of the day that, instead of the load factor being 5.5 per cent, it is 19 per cent, representing a maximum of 20 kilowatts.

Importance of the Diversity Factor

That chart illustrates every branch of the electric-light and power business. The problem that all of you have before you is this question of increased load factor. If the possibilities of the central station are to go on enlarging in the way that most of us hope, you have got to get it by an improvement of load factor. That improvement of load factor is produced by an improvement in the diversity factor, or the obtaining of customers who make the maximum demand on you for your product at different hours of the day, or different days of the week, or different weeks of the month, or different months of the year. Whether you are engaged in distributing, say, 5,000,000 kilowatt-hours a year, or whether you are engaged in distributing 500,000,000 kilowatt-hours a year, the underlying principles are precisely the same.

1. The map diagram to which reference is here made is one which Mr. Insull used in several of his addresses. It will be found in the present work as Fig. 1 of the chapter on "Centralization of Energy Supply," page 448. The accompanying data have been changed somewhat with the passage of time, but the diagram itself is identical in all cases where it was used.

I have attended many meetings of various electrical associations, and almost invariably the complaint of the representatives of the smaller central-station companies is that nearly all the speeches delivered and nearly all the papers read have reference to the conditions that exist in large cities. But let me tell you, gentlemen, that when those who represent small companies make that assertion they are failing in a recognition of the underlying principles that govern their business. These principles are the same in a town, say, of 10,000 people, as in a city of 500,000, or 1,000,000, or 2,000,000 people.

I have in mind a plant whose total output is 5,000,000 kilowatt-hours a year. The owners operate their business on a load factor of about 60 per cent. How do they obtain that figure? They have first the ordinary electric-light-and-power business. They have a few large manufacturing establishments to which they sell electricity at low prices. To this they add the street-railway business of the community in which they live, a town of 25,000 people. They supply the energy for a couple of interurban railways that come into that town, and they pump the water that supplies the city supply to the inhabitants of the town. I have in mind another town, of 50,000 people, where the amount of electrical energy sold is only about the same as that sold in the town of 25,000 people. In the second example the business is operated necessarily at a much inferior load factor, because the company confines its efforts merely to the light-and-power business. Instead of its plant being in action for, say, 50 per cent of the time, earning money to meet fixed charges and to satisfy the stockholders, this second company takes the position that it cannot afford to quote low rates, whereas as a matter of fact the rates that are quoted in the smaller town give a much greater share of profit. Not only that, but the securities of the first company are on a much better basis than those of the second. Furthermore, there is much greater satisfaction to the stockholders, for whom we all have to work. If you will just bear the result of that one block of apartments in the North Division of the city of Chicago in mind, and remember that the

diversity of the demand raises the 5.5 per cent load factor to a 19 per cent load factor; if you will take that one example home with you, you will have the secret of changing your business from a comparatively small business, one which hardly pays a return on the investment, to a business that will give you a very handsome return and make your securities as good as those of any of the larger companies.

Getting into a Larger Way of Business

In starting to develop the possibilities of the central-station business in Chicago we had to contend with many difficulties. We live in a community where the purchasing power of the people does not average particularly high; where there are still considerable stretches of territory within the city limits that are given over to gardening or truck-farming. We have to cover a territory, including the suburban towns surrounding us, of about 2,500 square miles — a territory twice the size of Rhode Island. In many parts of this area the manufacturing business is limited. Moreover, in the manufacturing districts the establishments are, as a rule, very large as compared with the average manufacturing establishment supplied by central-station companies.

The perfection of the alternating-current system, followed by the marvelous development of the steam turbine, gave us great possibilities of low cost of production of electricity if we could find the customers to take it off our hands. We were compelled, in order to develop a large business, to quote low prices, not only to the large consumer but to the small householder. The man who only pays us a little over $18 a year, and buys energy from us on the basis of his own personal load factor of 5.5 per cent, is able to buy our product at about 10 cents a kilowatt-hour. If his load factor improves comparatively little, he can buy electricity from us at a relatively lower price, according to what his load factor may be.

With the development of the steam turbine we decided to try and get in a larger way of business. We thought that by

possibly getting the street-railway business, or some of the street-railway business, and some of the elevated-railway business, the combination of these demands with our own would improve our load factor, partly as the result of the diversity-factor improvement and partly owing to the fact that urban railways have two peaks a day instead of one, and consequently their load factor would necessarily be better than ours. The results we have obtained so far in that direction are shown in Fig. 1. Our maximum load last winter was 158,000 kilowatts,

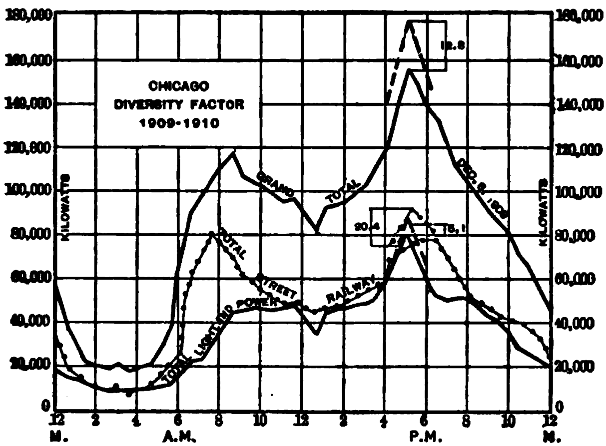


Fig. 1

as shown. The maximum demand of the street-railway business shows separately a diversity of a little over 20 per cent. The maximum demand of the various departments of our own business shows a diversity of a little over 5 per cent. But when those are put together we show this winter so far a diversity factor of 12.8 per cent. The winter is not yet over, and since I left home they have had more cold weather[1] in Chicago. The chances are that before the winter is passed, by a combination of the street-railway business, elevated-railway business

1. Cold weather increases the street-railway load, additional energy being required both for traction and for heating cars.

and our own business, we will have a diversity factor of about 20 per cent.

What does that mean? That means that we are able to supply ourselves and the railways with which we have contracts with their maximum demand for energy with 20 per cent less plant than the electric-light-and-power business and the railway business separately could supply themselves. I suppose it is a fair estimate to take the cost per kilowatt of central-station investment as somewhere near $100 a kilowatt. The saving for this particular winter, on the figures as I make them, amounts to somewhere about $3,500,000 in investment.

Looking Forward to the Entire Energy Business of the City

We carry that still further. We have tried to estimate the amount of business that we would obtain if we did the entire business of the city of Chicago. At the present time we figure that we are getting somewhere in the neighborhood of 30 per cent of the possible business offering in the city of Chicago. I do not mean 30 per cent of the business that we hope to get in the future as the result of the growth of the city of Chicago; I mean about 30 per cent of the business that is now there. We have generally the reputation of being keen after business; but if our estimates are correct the business that we now have is represented, so far as the light-and-power business is concerned, by the shaded portion of the lower left-hand square of Fig. 2. The unshaded portion of that square represents the business that it is possible for us to obtain. In arriving at the conclusion as to the business that we can obtain we don't simply include ordinary isolated plants; we include every industrial steam plant that is operated in Chicago. We take the ground that there is no reason for the existence of those plants if we can offer our product at a price that will yield us a profit in competition with the plants of the private owner. I don't at all mean what you ordinarily talk of as electric-light-and-power business. Of course the isolated plants that are still

running independently are included in this; but I mean all the large and small manufacturing companies that operate their own energy service.

Referring again to Fig. 2, the shaded portion of the middle square on the left represents the street-railway and elevated-railway business which we now have. The unshaded portion of the same square represents that portion of this class of business which we hope to get.

The subject of the electrification of steam railroads is one

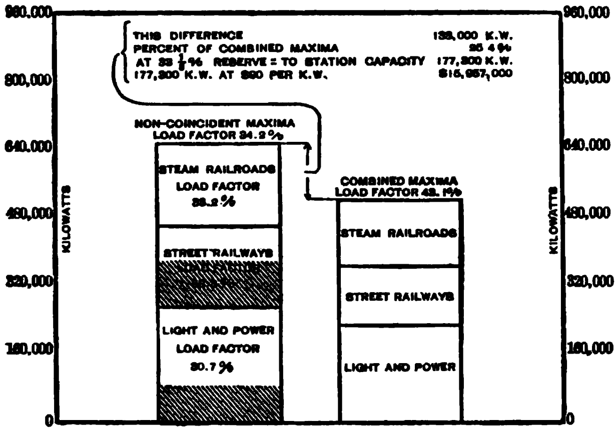


Fig. 2. Possibilities of Chicago Electric Service in 1909

very much discussed at the present time, and we have tried to arrive at a conclusion as to the amount of energy that would be consumed by the steam railroads centering in Chicago in the event of their electrifying their terminal properties. By "terminal properties" I mean the switching yards, etc., within the city, and a reasonable length of track outside of the city. In order to arrive at a basis of the possible business offering in that direction and the relation of the maximum load of that business to our load conditions we have taken the earnings of the railroads and assumed that the maximum load would come at a time of the year when they earn the most money. Based on that information, we estimate that there is the amount of

steam-railroad electricity business offering in and around the city of Chicago which is indicated by the topmost square at the left in Fig. 2.

How a Great Saving Can be Effected

In the left-hand set of squares in Fig. 2 we have placed the maximum of each business irrespective of when that maximum comes, and the result shows a little over 34 per cent load factor. To the right of that we have put the coincident maxima; that is, the maximum of the electric-light-and-power business occurring at the same time as the demand from the street railways and the demand from the steam railroads. I think probably, so that you will understand that better, it would be well for me to say that in our experience in figuring the possible steam-railroad load the maximum comes in the month of October. Every man here knows that the maximum of his electric-light-and-power business does not come in the month of October, so that the plant that would be supplying the steam railroads with their maximum in the month of October would be available to supply the maximum for the light-and-power business coming in December and the maximum for the street-railway business coming, in our part of the country, a little later, say in January. The result is that with an actual demand on us which would indicate a load factor of 34 per cent, if you figure it on the basis of the non-coincident maxima, which is the true basis, you attain a load factor of 43 per cent.

Now, what is the difference between the two? Not ten per cent, gentlemen; but it means that your plant would be in use almost one-third more time than if the maximum loads of those various lines of business all came at the same time. To do this entire business, based upon all the maxima non-coincident, would require in the city of Chicago an installation of 655,000 kilowatts (see Fig. 2); that is, a central-station installation of 655,000 kilowatts, or practically, as we talk horse-power, about 900,000 horse-power. On the basis of when the maxima are actually needed the amount of plant you have to provide to

take care of the whole of that great business would be rated at 522,000 kilowatts, or a difference of 133,000 kilowatts. If in addition to the cost of the central-station installation you add the cost of conduits and cables, which can largely be used in common for all the different classes of business, you arrive at the great saving of nearly $20,000,000, resulting from placing the generation and distribution of the energy required in a community of 2,500,000 people in the hands of one power company.

Combinations May Spell Economy

Within the last week or so the vice-president of the New York, New Haven and Hartford Railroad, appearing before one of your official bodies in Massachusetts, said that in his opinion within the next fifteen years the New Haven road between New York and Boston would be electrified throughout, and that the towns on the way would have the opportunity to obtain electricity at a very low cost — a cost dependent upon the cost to the railroad company which would necessarily be low, in his opinion, because of the very large amount of business that it would have of its own. My judgment is, gentlemen, that as central-station managers we must place ourselves in a position to do all classes of business. We must forget that we were originally started to supply an ordinary light-and-power business, mainly light. We must do what the gas companies have done. They have had to forget that they were formed originally as illuminating companies, and most of them today get a very large share, the preponderating share, of their income from other sources, mainly heating and cooking. What we have to realize is that it is our business to produce and distribute all of the energy required in the communities in which we do business. If the communities in which we do business are so small that we cannot get a low basis of production because we only manufacture on a retail basis, we must face the inevitable and remember that all business is the survival of the fittest. We will do well in that case to combine with those immediately around us; and if that combination is not large

enough to produce energy on an economical basis we may find it wise to go farther afield for our combinations.

Enlarging the Field of the Central Station

One of the first authorities in the world, in my opinion, on this subject of the possibility of the central station, is Mr. Coffin's friend, Dr. Emil Rathenau, the head of the great General (Allgemeine) Electricity Company of Berlin. A few years ago, before the possibility of low cost of production was brought about by the development of the turbo-generator, or rather just at the time when it seemed to be in sight, I was calling on Dr. Rathenau, and I asked him what he thought was the next step in the development of the central station. I had started at that time to build large stations. I started out in Chicago with the intention of having a station of 70,000 kilowatts, and owing to the remarkable engineering skill exhibited by Mr. Rice[1] and his staff that station, which I had expected would have a rating of 70,000 kilowatts, by the time it was finished, with the same building, the same number of boilers, the same grate surface, the same stack capacity, practically the same amount of money invested, had a rating capacity of 120,000 kilowatts. Dr. Rathenau did not quite agree with me on the question of the size of central stations; and I pointed out to him that my conditions were very different to those existing in most of the German cities, and that the possibilities of energy distribution in this country far exceeded those in Germany for a given amount of territory. But the thing that he did tell me, and the thing that started me thinking and led to my enlarging my field of operations around Chicago to a point where, as I say, we cover, not in one company but in three companies that work together and buy energy from one another,[2] a territory of

1. Mr. E. W. Rice, Jr., now (1915) president of the General Electric Company, of Schenectady, N. Y.

2. Referring, no doubt, to the Commonwealth Edison Company, of Chicago, the North Shore Electric Company, supplying suburban areas surrounding Chicago, and the Economy Light and Power Company, of Joliet, Ill. The North Shore and Economy companies were merged into the Public Service Company of Northern Illinois in 1911.

2,500 square miles — the statement of Dr. Rathenau was that he thought before he was through with the electrical business it would be possible that around the large centers of population one central-station organization would cover a radius of fifty miles. If we are to hold our business, and if we are to take advantage of the opportunities that are bound to offer in the next few years in supplying electricity to such large producers as the steam railroads — if that is your goal, gentlemen, you should get together; you must do away with small, uneconomical stations; you ought to get some such results as are shown on this chart.[1]

How Mr. Coffin and Mr. Insull Decided on a 5,000-Kilowatt Turbine Unit

This chart represents the increase in total kilowatt-hours generated by the Commonwealth Edison Company over a period of ten years. Ten years ago we produced about 35,000,000 kilowatt-hours. In 1909 we produced 490,000,000 kilowatt-hours, showing as a rate of increase a doubling up of our business, say, every two and a half to three years. Now take some of the advantages that we obtained in getting that output. The first advantage we had was that we were able to call on the General Electric Company to design for us very large steam turbines. Our ordinary electric-light-and-power business would not have warranted us in asking the General Electric Company to make for us 5,000-kilowatt turbines. I remember in the early days of the experiments with Curtis turbines Mr. Coffin[2] asked me if I would oblige him by trying a Curtis turbine. I had already purchased reciprocating-engine units that ran up to about 5,000 horse-power. I think the General Electric Company had an experimental Curtis turbine at that time of some 250 or 500 kilowatts, and Mr. Coffin asked me to

1. This diagram is another of those used on several occasions by the speaker. In this collection it appears (brought down to the close of 1913) as Fig. 20 of the paper on "Centralization of Energy Supply," page 469.

2. Mr. C. A. Coffin, then president, now (1915) chairman of the board, of the General Electric Company.

try a 1,000-kilowatt turbine. I told him it was not any use at all; that we had passed away beyond that; that the ordinary requirements of our electric-light-and-power business demanded 5,000-kilowatt units. I think that the development that we have had in the last ten years, or especially in the last six years, is owing very largely to the courage displayed by the General Electric Company in jumping from a little experimental machine of 250 or 500 kilowatts and being willing to take the risk of manufacturing, if we were willing to take the risk of installing, steam turbines of not less than 5,000 kilowatts.

Just see the results that we have obtained from the use of the turbine. Here are "tons of coal burned."[1] From 1901 to 1904 the tons of coal burned show just about the same rate of increase as the kilowatt-hours manufactured, but between 1904 and 1905, when we began to get the use of our turbines, the lines crossed, and the difference between the kilowatt-hours generated and the tons of coal burned widened right along. Or, putting it another way, the pounds of coal per kilowatt-hour produced went down constantly, as shown in the diagram. While that result was mainly owing to the remarkably high efficiency of the turbo-generator unit, it is also owing to the improvement in load-factor conditions. The addition to our business of large wholesale customers, such as street railways and elevated railroads, has resulted in our being able to use our manufacturing plant 33.33 per cent more than we were able to use it before we went into that line of business, and there is no doubt that part of the reduction in the pounds of coal per kilowatt-hour produced comes from that improved load factor.

Benefits for the Small Customer Also

The larger volume of business introduces better conditions of operating from month to month. The lowest load factor at which we have to operate our stations is in the month of November[2] and is 43 or 44. Such a condition of operation,

1. Referring to Fig. 20 on page 469.

2. See Fig. 3 of chapter on "The Larger Aspects of Making and Selling Electrical Energy," page 82.

being able to operate our plant at practically 44 per cent of the time for a whole month, affects not only the cost of our total fuel used, but it affects our labor costs, our repair costs, and every item, including our interest and depreciation costs, that goes to make up the total cost of energy at the switchboard. The result is that we have seen our way to a rapid reduction of rates, not only to our small consumers, but also it has enabled us to introduce very much more liberal rates with relation to wholesaling electricity to very large industrial establishments.

We have gained experience in producing large volumes of energy, necessarily at low prices, because in order to meet the element of competition, that is, the competition with the railway company in producing for itself, we have had to quote low prices. But the mere fact that our business is conducted on a small margin has taught us to study questions of cost of production, and I am confident that one of the reasons for the fact that we are able to produce electricity cheaper than anyone else on either side of the Atlantic who has to buy coal is owing to the fact that the apparent margin of profit between cost and selling price on upwards of half of our business is so small that we have ever before us the necessity of low cost of production, highly efficient plants, the best kind of upkeep, and the obtaining of our money at the lowest possible price in the markets of the world. Naturally, we are able to meet the last requirement owing to the large volume of business with which we have to deal.

Now I want to direct your attention to the following table. It gives a comparison of customers in the residence section of Chicago in October, 1908, and October, 1909. In October, 1908, we had 25,900 flats, and in the same month in 1909 we had 37,940; we had 5,232 houses the first year and 6,765 the second year, and we had 3,559 small stores the first year and 4,842 the second year. The income we obtained in 1908 was $41,000 from flats, and $62,000 in 1909; $15,000 from houses in October, 1908, and $20,000 from houses in 1909. In small stores the comparison was $15,000 and $20,-

RESIDENCE SECTIONS OF CHICAGO

	Flats	Houses	Small Stores
Number of Customers in —			
October, 1908	25,900	5,232	3,559
October, 1909	37,940	6,755	4,842
Income in —			
October, 1908	$41,323	$15,768	$15,598
October, 1909	62,209	20,869	20,885
Average Income per Customer in —			
October, 1908	$1.59	$3.02	$4.38
October, 1909	1.64	3.08	4.32

000. Now take the average income per customer. In 1908 it was $1.59 in the flats and in 1909 $1.64; in the houses it was $3.02 in the former year and $3.08 in the latter year, and in the small stores $4.38 the first year and $4.32 the second year. Between those two periods there was a slight reduction of price; that is, of list price.

"IS THE FAULT WITH YOU OR WITH YOUR COMMUNITY?"

Why is it that with reducing prices we get an increasing income in two cases, as shown, and a reducing income in the other case? The reason the income was reduced in small stores was owing to the fact that there electricity is used for lighting. The increase in income in the flats and houses is simply the result of advertising, canvassing, educational work of all kinds. Our experience is that the lower we set the price per unit of energy, if we will get at our customers and educate them to the uses of electricity, the greater is that use, within certain limitations. It follows that our bills, and consequently our profits, are greater.

Almost as important as low cost of production, as massing of production, is the question of selling. You have a notable example of the expenditure of money in the matter of selling right here in New England. I don't know of any more progressive company in that respect than the company presided

over by my friend Mr. Edgar,[1] and if you expect to sell kilowatt-hours, if you expect your customers to use those kilowatt-hours at other times than the peak, you must educate them how to do it, and you cannot educate them how to do it unless you spend money. The best possible return that you can get on any expenditures that you may make is the return that you will get on money expended in exploiting your business and endeavoring to add to your number of customers, we will say. But still more important is the effort to get the customers that you have to use your product throughout as much of the twenty-four hours as possible. The field is almost limitless in this direction. If you will provide low cost of production and low selling prices, so as to enable your customers to use the thousand and one devices that consume electricity at times other than the time that brings your maximum load, you will, I am sure, make your properties of far greater value. You will, too, become far more popular with the community, because the man who can constantly reduce his price must of necessity become more popular in the community. Moreover, you will sell a far greater number of kilowatt-hours per capita than you are doing at the present time. I don't want to be personal, and would not think of drawing attention to any individual case, or the case of any one company; but go over the records that are published by your own state commission; study the question of the kilowatt-hours sold per capita when you get home; and if you happen to be the low fellow find out whether the fault is with you or whether the fault is with your community.

The average purchasing power of the people living in the New England states is large. On the variation in the electrical energy they use per capita I won't take the lowest amounts, because they seem so absurd; but the figures vary in towns of reasonable size from 20 kilowatt-hours sold per capita per year to 74. If I were interested in a New England property, or if I were running it myself and I found that I could only reach the

1. Mr. Charles L. Edgar, president of the Edison Electric Illuminating Company of Boston.

low number of kilowatt-hours sold per capita, I would think that somebody else should take my job, because I would know that such a condition must finally very seriously affect the investment for which I was responsible. The situation must of necessity compel high rates for energy. High rates for energy may exist in isolated cases today, but they cannot exist permanently in this part of the country, any more than they can in any other part of the country, when you have before you the example day after day of the price at which it is possible to manufacture and sell electricity at a profit right in this city of Boston.

Supply the Need of the Large Users, or They May Supply Yours

Before I sit down I want again to emphasize, above everything else, the importance of working in the direction of being the sole producer of electrical energy in a given community. I don't know that it will come in our time, although it looks very much like it, but if the steam railroads should go to electricity as a motive power there is no question that they will become great factors in the production and distribution of electrical energy, certainly in the thickly settled portions of the United States. We have right within ourselves the ability to get that business. It is not such an easy matter for the steam railroads to finance their development; they don't find it so easy to borrow large sums of money; and if they can be relieved of the investment cost for providing the plant necessary to produce electricity I should think that they would welcome that relief, just the same as they welcome relief from having to provide the capital to run sleeping cars, or to build locomotives or passenger cars or freight cars. The natural thing for us to do is to be the producers of energy; and I don't know of any better part of the country, any more favorable part of the country to pick out than the states along this portion of the Atlantic seaboard. You have large centers of population within every fifty or seventy-five miles. You have existing in those centers of population large central-station plants. My

own belief is that in the future those central-station plants will either supply the large users of electricity with their energy or else those large users will be supplying the central-station companies, in the territory in which they operate, with electricity and the central-station companies will become simply distributing companies.

I think before closing I will give you some figures bearing on this subject from the situation existing around New York, where the first effort at electrification of steam terminals has taken place. The New York Edison Company's load factor is about 28.9 per cent. The New York Central Railroad Company's load factor is about 33.7 per cent. The Interborough Rapid Transit Company's load factor is about 39.5 per cent. If you put them all together the load factor of all those businesses together is somewhere between 42 and 45 per cent. Any one of them separately would only be able to use its plant practically from 30 to 33 per cent of the time. If they were combined and bought their energy from one central generating company, the plant of that generating company would be earning money practically 50 per cent more of the time than if those plants were run separately. If I understand my business correctly, massing of production for all purposes is an economic necessity; and there is no more reason for building separate plants for different classes of business in the city of Boston or the city of New York than there is for building them in the city of Chicago, where the results have been mutually satisfactory both to the company which I operate and to the surface and elevated roads that pay us $2,500,000 a year for supplying them with electrical energy.

TWENTY-FIVE YEARS OF CENTRAL-STATION COMMERCIAL DEVELOPMENT[1]

IT IS an especial honor, which I very much appreciate, to be given the opportunity of addressing you on so notable an occasion as the celebration of the twenty-fifth anniversary of the starting of this association. To those of us who have been in the central-station business since its inception it hardly seems possible that twenty-five years have passed since the organization of the association in Chicago on February 3, 1885. If, however, we reflect on what has been accomplished in that time and recall that at our first meeting our membership was only 71, whereas, if I am correctly informed, it is at the present time 5,369, we would seem to have occupied about the allotted time in our growth from birth to that of a young but sturdy manhood.

The organization was projected originally more in the interests of the electrical manufacturers than in the interests of the central-station companies. The change during the first few years was gradual, but for the last twenty years the National Electric Light Association membership has been composed of the companies engaged in the central-station business of the country. Within a comparatively few years still further modifications in our membership have taken place, and today, besides having direct membership of the central-station companies and the officials connected with them, we have state organizations affiliated with us as well as company sections composed of company employees. I know of one company section in one of the large centers of population having a

1. An address delivered on May 25, 1910, at the St. Louis convention of the National Electric Light Association. This paper was written in advance and read from manuscript.

membership of upwards of 400, representing about fifteen per cent of the total central-station employees of that particular community.

Thanks Due to the Electrical Manufacturers

In 1885 when the National Electric Light Association was formed, the development of the central-station business was confined almost entirely to a few companies established under the auspices of the Edison Electric Light Company. The companies forming our early membership were not engaged in what we understand today as central-station business but were either arc-light manufacturers and supply men or those companies that were engaged in series arc lighting, doing practically no other business, except that, in a very few cases, a small amount of power and series incandescent business was transacted.

If you will look over the list of the people who attended the first meeting to organize the National Electric Light Association, you will not fail to be impressed by the lack of central-station men on the committee of arrangements, or on the committee of invitation, or on any of the other committees forming part of the original organization. Our thanks for the establishment of this association, which in later years has wielded such a remarkable influence and has been of such wonderful assistance in the development of the central-station business, are really due to the electrical manufacturers and electrical supply people whose business was to sell series arc-light plants for city lighting and who, at the time they started our association, had little or no conception of the development of the central-station business as we now understand it.

How the Business Was Developed

The strides made in the commercial development of the central-station business have been so rapid that we hardly realize how short a time ago many of us were doubtful as to the ultimate outcome of the business in which our members are engaged.

At the Niagara Falls meeting, in 1897, I well remember the paper read by my friend Mr. T. Commerford Martin,[1] on the "Daylight Work of Central Stations." He started his paper by stating that the central-station industry had in some respects been a disappointment; that after nearly twenty years of work the companies restricted themselves injuriously, by remaining mere lighting companies, and he asked the question what would become of the central-station companies if a new lighting medium came into vogue and we were deprived of our illuminating business entirely.

To get statistics of the early days of the business is a difficult matter, but Mr. Martin on the same occasion showed that in 1886 there were 410 central stations in the country; that only 300 of these furnished any statistics and that of those 300, 226 were only doing a night business.

Assuming, as Mr. Martin did, that those who did not report were in the same class as the 226 doing only a night business, we find that out of 410 so-called central-station companies 325 were doing business only between dusk and daylight.

From these figures I should judge that at the time of the starting of the National Electric Light Association in 1885, there were not more than eighty companies engaged in serious central-station business, that is, in selling electrical energy for all kinds of purposes every hour of the twenty-four, whereas today there are probably upwards of 6,000 central-station companies in the United States. It is probable that to say $10,000,000 represented the cash investment in the business in 1885 is naming a very liberal amount, whereas it is authoritatively stated that between $1,000,000,000 and $1,250,000,000 represents the total sum of the capital employed today in the central-station industry of this country.

Early Central-Station Enterprises

The first commercial central-station plant erected anywhere was that installed by the Edison Electric Illuminating Company

1. For many years one of the editors of the *Electrical World*. In 1909 Mr. Martin became secretary of the National Electric Light Association.

of New York. It served a territory about a mile square, extending as far south as Wall Street. The station was located on Pearl Street one or two doors south of Fulton Street. The system employed was the Edison two-wire main-and-feeder system. It was put into operation September 4, 1882. Some time after the construction of the New York plant was begun, a small central-station plant, of only 250 16-candlepower incandescent lamps, driven by water power, was projected at Appleton, Wisconsin. The Appleton plant was started on August 20, 1882, just two weeks before the New York station was put into operation; so that, judging by the date on which the first commercial plant was put in operation, while New York can lay claim to the credit of projecting the first central-station system, Appleton, Wisconsin, in the heart of the Central West, seems entitled to the credit of putting into operation the first commercial central station and to have been the pioneer in a business which in less than three decades has grown from nothing to an investment in this country alone which can only be expressed in ten figures.

The commercial development of the business was of necessity, in the early days, hampered, among other things, not only by a lack of knowledge of conditions governing the relation of the true methods of selling electrical energy to the cost of producing it, but also by the high capital cost of the plant used. However, it might be well to state that the first million dollars invested in the central-station business was that provided by the local Edison company of New York, whose plant was put in service in September, 1882; and this first capital showed substantial earning capacity, and I believe paid dividends before additional capital was raised by the company.

But what could be done under the favorable conditions existing in New York could not be done elsewhere, and the commercial development had to await the efforts of the inventors in the direction of reducing first cost. It is not my purpose tonight to detail the marvelously successful work of the many brilliant inventors whose efforts, following Edison's original invention of the central-station system, have contrib-

uted so much to the success of our business. I shall but mention what occurs to me as the leading features which from the technical and engineering side have made the central-station business of today possible.

The change from the two-wire system to the three-wire system, saving 66.66 per cent of the copper necessary in distribution, and the reduction in the energy consumed by the incandescent lamp from 6.5 watts per candle in 1882 to 3.1 watts per candle in 1890, made the central-station business a certain financial success in cities of the first, second and third rank. The introduction of the alternating-current system, first established in this country at Greensburg, Pa., in 1886, by the Westinghouse Company, made the central-station business available for the small towns throughout the country. The building in 1890–1891 of slow-speed electric generators directly connected to highly economical reciprocating engines, usually of the vertical type, was the first step in the direction of reducing first cost of central-station investment, and also in reducing the operating cost of the energy produced. This made possible, and was followed in 1896, by the introduction into this country of the use of high-tension alternating transmission lines operating substations, in which were installed rotary or stationary transformers, depending on whether direct or alternating current was to be distributed therefrom.

Massing of Production

The combination of the direct-connected dynamo-engine unit of high efficiency, the high-tension transmission lines and substations, forced, on account of the saving made, the abandonment of small generating stations and the massing of production on a very large scale. The limit of the size of units of power was reached by reciprocating engines at about 5,000 horse-power. A demand sprang up as the volume of energy produced increased, partly from centralizing production and partly from increased business, for prime movers of greater size, lower investment cost and lower operating cost; resulting in the de-

Boiler Room (420 Feet Long) in the Quarry Street Generating Station of the Commonwealth Edison Company, Chicago

velopment of very large steam turbo-generators, which operate today in units of upwards of 20,000 horse-power, and which will within the next year be operating in units of 30,000 horse-power. Within the last two years the introduction of higher efficiency incandescent lamps such as the tungsten lamp has greatly reduced the cost of light.

I have tried in the foregoing to picture to you in as few words as possible, the technical, or rather the engineering, development of the central-station business during the last quarter of a century. How far the commercial development of the business has been forced by the work of the engineers, or how far the necessities of the salesmen and the business managers forced the technical development, it is difficult to say; but the fact remains that as the possibilities of economical investment and economical production have increased, the business obtained and the energy distributed have increased by leaps and bounds, so that it is no uncommon occurrence for a central-station company to double its output every three to four years.

The Question of Rates

In the early days of the development of the central-station business, say for the first ten years of its existence, from 1881 to 1891, the customers of the central-station companies looked upon our product as more or less of a luxury. Partly owing to a lack of knowledge of the conditions governing the relation of cost and selling price, and partly owing to the difficulty of getting our customers to make the necessary investment to connect with our system, our service was used rather as a luxury or an advertising proposition than as a necessity. In the early days of the business rates were very high, corresponding to gas at about two dollars per thousand feet. The discounts from these rates were very small, and most large consumers of electrical energy, even within the area served by a central-station system, found it to their advantage to install their own plants and manufacture their own electrical energy. The result to the central-station company was that the central-station business

was confined almost entirely to short-hour consumers, the consequence being that the investment of the central-station company was in use but a very few hours out of the twenty-four, the interest cost to the company being necessarily very high and the operating cost correspondingly high. It was not until the early nineties that some of the managers of the large central-station properties of the country appreciated the fact that if they desired to place their business on the basis of a general public necessity it was necessary for them to rearrange their rates on such a plan as would give the long-time consumer, the man who used the central-station company's investment most steadily during the year, the lowest possible price; and the recognition of the necessity of meeting this condition may possibly have had as much to do with reducing operating costs and reducing interest and depreciation costs as have the wonderful work of the inventors and the marvelous skill of the engineers.

Proper Methods of Selling

It would have been of very little use to the central-station manager to have been able to take advantage of the large units produced by the manufacturers for the production of energy or of the economies introduced in the distribution systems by the introduction of high-potential alternating currents and transformer substations, if the methods of charging for service had not broken away from the plan on which the business was originally started. If you will take the statistics of any of the central-station companies, whether they be large or small, and look for the reasons for the enormously rapid growth of the central-station properties of the country, you will, I am confident, find that the rapid increase in the amount of energy sold responds absolutely to the putting into use of liberal methods of dealing with the company's customers.

It matters not by what name you may call it — whether you speak of it as the improvement of your load factor, whether you speak of it as creating a day load — the fundamental reason for the success of the business in which we are engaged is as

much an appreciation of the proper methods of selling our product as the opportunity to use the many brilliant inventions which have been made by the great technical minds of our time.

I am dwelling upon this subject not with any idea of belittling the great achievements of the inventors and engineers whom it has been our good fortune to have had working in our interests in the fields of discovery and engineering, but for the purpose of impressing, more especially upon the younger men connected with our organization, the great importance of the commercial side of the business and to point out to them the advantage, alike to themselves and the business itself, of their bestowing upon the commercial side of the business as much thought, if not a greater amount of thought, as that which they bestow upon the technical operation and construction side of central-station development.

As a manager of central-station properties it is often brought home to me that while it is comparatively easy to obtain first-class operating assistance, and while it is not a matter of great difficulty to obtain engineers of constructive capacity to design and build our central-station plants and systems, it is a far greater problem to obtain trained technical men who have made a thorough study of commercial conditions to take part in the commercial development of the business. I am inclined to think that if during the next quarter of a century we are to make relatively as great progress in the development of the central-station business as has been made in the last quarter of a century, it will be necessary for the technical institutions of the country to give greater prominence to the commercial side of the central-station business and, when qualifying their students in electrical engineering and mechanical engineering, to teach them more of the true conditions governing commercial development.

To the young engineers engaged on the operating side of the business my advice is that they familiarize themselves with the commercial conditions under which the companies for which they work have to conduct their business. If they will give thought to the commercial side of the business and qualify

themselves to take part in the sale of the product of the company, if they will devise new methods of selling the product, new methods for obtaining consumers of the energy produced by the central station, they will stand a chance of achieving distinction and profit far greater than most of them can achieve in the operating and purely engineering side of the business.

What are the Real Functions of a Central Station?

The possibilities of central-station business, while great today, must be far greater in the future; and in trying to point out what those possibilities are it may not be amiss to discuss what is the real function of a central-station company. Is it simply to light the streets of the city, as most of the electric-lighting companies thought was their function twenty-five years ago? Is it merely to do house-to-house lighting, as was (with the incidental power connected with it) the business inaugurated by the few Edison companies a little more than twenty-five years ago? Should a central-station company be engaged merely in production of power for industrial purposes, or for railway purposes — whether the railway be urban, interurban, state or interstate? Or should the central-station company embrace all of the functions stated above and produce all of the electrical energy needed in a given community or a given area?

The maximum load of the electric-lighting business in this latitude comes in December and is accentuated by the industrial power load. The maximum load of the street-railway business comes more often in January than in December, especially in the Central West, owing to the conditions of temperature, involving heating as well as traction. The maximum load of the steam-railroad business, so far as I have been able to figure it, comes in the middle of the summer in Connecticut and Massachusetts, towards the end of September around New York city, and in October around Chicago and St. Louis. The maximum load of a waterworks comes in a great many instances, if ample storage is at an elevation, at the convenience of the producer; and in any event, it comes at a time of the year when the de-

mand for total energy used in a given community for other purposes is by no means at its maximum.

Why should all these operations for the production of energy be dealt with on a separate basis? Why not concentrate them all, and by so doing get low cost of production, low capital investment (because of the elimination of duplication of investment) and increased diversity of demand for energy, and, what is of vast importance, consequent low prices to all users, whether they be the occupant of a simple cottage, spending fifteen or twenty dollars a year for light, or a large railway system using fifty or seventy-five thousand kilowatts of energy.

What I am advocating is merely the extension of the central-station idea. It is applying the same principle, on a very large scale, which underlies our business, which is the advantage of increasing the diversity of the demand and increasing the quantity of the output.

If you will apply the arguments that you use to persuade a possible customer to give up his isolated plant to the larger questions of manufacturing and distributing electrical energy, you must come to the conclusion that our true function as central-station companies is not only to supply the energy required in the community in which we live, but also to supply the energy required to carry us to the next community when we go to visit our neighbor, or in any case to carry us part way.

It seems to me that the development upon these lines must in the future inevitably occur. Already we have areas in the eastern and central western states where the extreme distance of territory from one end to the other, exceeding fifty or sixty miles, is served from one distributing system. These areas are far exceeded on the Pacific Coast, where large water-power combined with steam stations serve a large extent of territory with central-station service.

A few months ago the vice-president of the New York, New Haven and Hartford Railroad, before one of the official bodies of Massachusetts, said that in his opinion within the next fifteen years the New Haven Railroad, between New York and Boston, would be electrified throughout, and the towns on

the way would have the opportunity of obtaining electrical energy at a very low cost, the cost dependent upon the cost to the railway company, which, in his opinion, would necessarily be low because of the very large amount of business that they would have of their own.

Possible Electrification of Steam Railroads

The work of the New York Central and Pennsylvania railroads in the way of electrification has gone hand in hand with the work of the New York and New Haven Railroad, and if the steam-railroad people look forward to electricity being supplied at very low cost throughout Connecticut, Massachusetts and Rhode Island, as a result of the production of energy in large quantities for the electrification of the steam railroads in those states, the same thing must necessarily happen throughout the whole of the densely settled portion of the United States, if the reasoning of the vice-president of the New York, New Haven and Hartford Railroad be correct.

But it would seem to me that our function as producers of electrical energy should, with the tendency towards electrification of steam railroads, become very much broadened; and instead of its being the exception, as it is today, for a central-station company to cover any large amount of territory outside of the municipality in which it is mainly established, its operations will become far more extensive. If the steam-railroad men of the country want electrical energy produced economically, they should find it to their advantage to come to us as specialists in the manufacture of electrical energy, taking advantage of our experience in the best methods to pursue, taking advantage of combining their necessities for electrical energy with the necessities existing in the communities in which we operate, which combination will result in economies which neither can obtain separately. This will lead to the establishment of large central-station plants capable of supplying all the requirements in the way of electrical energy for a large area of territory surrounding the centers of population.

If our members will do their share towards working to such a desirable end, the possibilities of electrification of steam railroads will be brought much nearer to us. The financial burden of making the change would be divided, the steam railroad providing the necessary capital for electrifying its right-of-way and changing its rolling stock, the central-station companies of the country providing the capital for building the large generating stations and transmission lines to convey the electrical energy to the railroads and other consumers along the right-of-way.

Regulation and Monopoly

Before closing my remarks I desire to refer to the relation which the central-station business bears to the communities in which we operate. The business in which we are engaged can be most successfully operated as a monopoly business. If the communities which we serve are to get electrical energy at the lowest possible cost, they can only expect to achieve this by preventing duplication of investment and by concentrating production under one organization. The fact that low prices cannot be permanently obtained by the old method of encouraging competition is being very generally recognized today; and as this becomes more and more recognized, the regulation of our business, our methods of conducting it, our methods of financing, will be subject more and more to governmental supervision in some form or other.

This demand for supervision, while it certainly is a trend of the times, is also an appreciation on the part of the people of this country that the destructive effect of competition in public-service business ultimately means greater burdens on the community through the maintenance of high rates to give a return on the excessive capital tied up as a result of duplications of plant. Fortunately for us, living as we do in a country having had tremendous developments and capable of almost unlimited development in the future, this policy of competitive regulation has had a limited effect only, as the growth in the communities in which we operate and the fact that our business

has by no means reached a point of saturation in the large and small cities of the country have enabled us, from increased business, to absorb and bring into active use a great deal of the capital which during the period of competition seemed to be an unnecessary waste.

It should be borne in mind that the more closely our business is supervised and regulated the greater are the chances of our being protected against ruinous competition, which today is mainly instigated by those who desire to take this means of acquiring our existing business. While we may not care to be hampered by the rules and regulations established by commissions created to watch over our operation, the further these commissions go into our business the more will they be convinced that the best results can be obtained only by regulated monopoly, and that competition is alike as ruinous in the long run to our customers as it is to the central-station company itself. The result will be that our monopoly of the business will be secured, our securities will stand in higher credit and new capital will come flowing into our coffers for the extension of our business. I do not myself view with any alarm the proper regulation of the business in which we are engaged, but feel that its stability may be greatly increased thereby.

Friendly Relations with Customers

There is another phase of our relations with the community which all of us should do our best to foster. I refer to a friendly feeling of relationship between the public-service corporation and its customers. As a rule the tax collector is not supposed to be popular; and many people look upon payments which come regularly every month for the use of a public utility as more or less in the form of taxation; but I do think that it is possible for a central-station manager, by liberal methods of dealing with his customers and by absolute fairness whenever there is a matter in dispute, to encourage a feeling of friendliness towards the corporation which will build up a valuable asset in the shape of good will.

Unfortunately, in the last few years there have been a number of people engaged in arousing a spirit of hostility to the corporate interests of the country. I do not refer alone to corporate interests running natural or artificial monopolies, for this agition has been directed as much against the mercantile business run on a large scale in the form of a corporation as against the public-utility corporation, whether municipal, state or interstate. A great many of the people engaged in this class of agitation have done it to serve their own particular ends; others, highminded and honest citizens, have thought that the interests of the state were menaced by corporate monopolies and that only by agitation could these interests be preserved.

But no little damage has been done to the corporate interests of this country by the action of some officials of corporations, who seem to have had much concern for the profit of the moment and little or no concern for the permanency of their investment in the future. We central-station managers ought to look upon ourselves as semi-public officials and so conduct our affairs with the community as to give us the advantage of a reputation for absolutely fair and impartial dealing. We should preach the same doctrine to our subordinates and insist upon the same policy being carried out in their dealings with the public. If such a course is pursued, we will not only be helping to improve the opinion of the community of corporations generally, but will be establishing our own business on so firm a basis as to add to the permanency of our investment and give promise of prosperity in the future.

EMPLOYEES URGED TO STUDY ECONOMIC QUESTIONS[1]

ONE OF the greatest pleasures that a busy man can possibly enjoy is the good will of those associated with him. No greater pleasure is ever afforded me than to meet with those whom it is my privilege to work with and to lead in this great enterprise of electricity supply which we have been engaged in developing during the last two decades.

Before saying anything about our own business, I want to say a few words to you about the National Electric Light Association. The National association is the leading body in every respect in this great industry, representing a capital of upwards of a billion and a quarter of dollars, and its influence is felt in every community, an influence exercised alike for the good of the communities in which our member companies operate and for the benefit of the companies themselves.

If, in going to different parts of the country to look into some electric properties, you happen to find a property that is run down at heel, with plant in relatively poor condition, whose organization is at odds with the community with which it has to do business, and whose methods of business are ten years behind the times, you can be pretty sure that that company is not a member of the National Electric Light Association. If that company were a member of the association, and if its officials attended the national conventions and took advantage of the accumulation of information produced by the best

1. Mr. Insull has been an earnest advocate of co-operation in the electrical industry, both in the larger sense, as represented by the national societies, and in his own organizations. In particular he has been a warm friend of the National Electric Light Association, and he has given the company sections of that organization every encouragement. The address given here was delivered at the annual meeting and dinner of the Commonwealth Edison Company Section of the National Electric Light Association in Chicago on November 1, 1910.

brains of this, one of the foremost industries of our times, it would not be possible for such a company as I have spoken of to be satisfied with the results achieved.

Advantages of Membership in Company Sections

The development that has taken place in the last two or three years leading to the establishment of the company branches or sections of the association must finally place the men who fail to recognize the benefits that they can obtain by becoming members of the company sections in relatively the same position, so far as their own company is concerned, as is occupied by the electricity-supply companies that fail to recognize the noteworthy benefits of joining this association. I cannot urge upon you too strongly, I cannot urge upon those who, unfortunately, are not in this room, and who are connected with the Commonwealth Edison Company, the benefit that they can obtain, the absolutely necessary knowledge that they can obtain, if they will profit by the advantages that can be obtained from membership in the company section here in Chicago.

I was very much struck with the remarks of your incoming chairman,[1] his reference to the low percentage of members of this branch who have left our company's service, and his reference to the fact that the members of this branch enjoy a higher average pay than the non-members of this branch, working for the Commonwealth Edison Company. It is pretty good evidence that the best brains of the company are represented in this room. I am not given, as you know, to throwing bouquets; but the very best way that you can fit yourselves for positions higher up in this great industry, positions which are open to all of you, just as much as they have been open to me and to the other gentlemen sitting at this table — the very best way that you can fit yourselves for future advancement, enabling you to deal not only with the particular work that you are doing at the moment, but with work of much greater consequence, and consequently bringing much greater pay; the

1. Mr. Ernest F. Smith, superintendent of substations for the Commonwealth Edison Company.

very best way that you can fit yourselves for such positions and be candidates for advancement in our company organization — is to devote yourself to the work which is before you in the Commonwealth Edison Company Section of the National Electric Light Association.

This is the twenty-sixth year of the existence of the National Electric Light Association. I well remember attending a meeting some twenty-four years ago in the old Grand Pacific Hotel, when it was impossible to muster more than about one-sixth of the number in this room tonight as representatives from all over the country of the great industry with which we are associated. And in recalling that occasion, I cannot refrain, at the cost of the reiteration, of rendering my tribute to the enormous influence that this association has had on our industry; to the broadening effect that it has had on all of us who have attended the national conventions, and to the vast amount of information that we have obtained by the exchange of ideas and the discussion of those ideas as to the best way of operating the business.

I rather think that we plume ourselves too much on the number we have in the Commonwealth Edison Section of the National association. A very good test of the number of members we ought to have would probably be the numbers of employees of the Commonwealth Edison Company who have the right to join our savings fund. At the present time we have on our payrolls over 2,000 men who have been with us upwards of a year, and consequently have the right to join that fund. And yet only 485 of those men have recognized the benefits that they can gain by becoming members of the company section.

The Best Investment a Man Can Make

Mr. Freeman[1] has very kindly referred to the Commonwealth Edison Company as the premier organization of its

1. Mr. W. W. Freeman, who was a guest at the dinner, was then the president of the National Electric Light Association. For a number of years Mr. Freeman was vice-president and general manager of the Edison Electric Illuminating Company of Brooklyn. In 1914 he became president of the Union Gas and Electric Company of Cincinnati.

kind the world over. I think his kindness in that respect is a little exaggerated, but still we will accept the compliment as blushingly as we may, Mr. Freeman. Now, if we are the premier organization — anyway we will accept it for the purpose of argument — if we are the premier organization in the electricity-supply business, it is but natural that we should have the premier organization as a section of the National Electric Light Association. Instead of being satisfied with only a little over 20 per cent of the employees of our company as members of this organization, we should not be satisfied until we can get every man who is qualified to join our savings fund as a member of this company section.

It matters not whether a man is in the contract department, or in the operating department, or the auditing department — the employees of all departments can obtain much benefit by the knowledge that they would get of other branches of the business if they would become members in this company section.

I hope when we meet again a year from now that our membership will be doubled.[1] It certainly ought to be. The men who have the right to join the section can well afford to do it from a financial point of view. It is the best possible investment they can make, as I naturally assume that all of them hope to get along and rise to positions of authority in this business either here in Chicago or elsewhere. So much for the company section.

Some Statistics of Ten Years' Growth

I was casting around this afternoon, or rather yesterday afternoon, for something on which to pin my speech here this evening, and one of my very kind assistants reminded me that at a dinner of the employees of the old Chicago Edison Company, held at Henrici's old restaurant on Adams Street, some ten years ago, I made the statement that it was not at all beyond the range of possibilities that the corporation with which we are all connected, and justly proud of being connected with, would some day have invested in its business upwards of a

1. It was more than doubled at that time. See "Opportunity for Advancement," page 234.

hundred millions of dollars, and I even ventured the statement that the Harrison Street generating station, which at that time was probably the first or second generating station in the country, would ultimately become a substation. And our genial secretary and treasurer,[1] who heard the remark, reminded me that about the same time I made a similar remark at a meeting of the board of directors of the old Edison company, and when I intimated that I thought we might at some time have employed in our business a sum equal to a hundred millions of dollars, some of the directors looked askance and wondered whether my reason was a little affected.

Now, what have we done in the period that has gone by since that pleasant little dinner we had at Henrici's? I have had some figures gathered together here which I thought would interest you as showing the growth of our business.

Our connected load expressed in 16-candlepower equivalents in the year 1899 was 769,115 lamps; in the year 1910, expressed the same way, it amounts to 8,143,908 lamps. In 1900 we had 13,919 customers and in 1910 we have 124,607 customers. The maximum load in 1900 was 14,260 kilowatts, or was a little over 19,000 horse-power; our maximum load last winter was 158,000 kilowatts, a little over 211,000 horse-power. Our maximum load this winter will probably run up to 185,000 kilowatts, a little over 240,000 horse-power.

Our kilowatt-hours generated in 1900 were 34,370,000 kilowatt-hours, an amount which we do not think much of billing to one customer at the present time. Our kilowatt-hours generated for the fiscal year just closed, to the end of September, were 601,712,335 kilowatt-hours, a greater output than that generated in any city of the world, even in the great city of London, with its six millions of people and covering an area almost the equivalent, I think, of one of the smaller states of the Union. In 1900 we had nine generating stations running. Today we have three generating stations running, and I suppose one of those will inevitably go out of use within the next few years.

1. Mr. William A. Fox, made vice-president of the company in 1914.

Turbo-Generator Room in Quarry Street Generating Station of Commonwealth Edison Company, Chicago. Here are Six Vertical Units each rated at 14,000 Kilowatts

In 1900 our load factor, which, after all, is the controlling element in the question of making or losing money, rather than the selling at a high price or at a low price — our load factor was a little under 29 per cent. In 1910 our load factor was a little over 41 per cent. In 1900 our gross earnings were $2,-650,058, and for the year ended September, 1910, they were $13,083,725. The total money employed in our business in 1900 was $14,391,971, and the amount of money employed in our business at the present time is $67,500,000. In these days when so much is said about corporations not bearing the burdens which they ought to bear, I deem the item of taxes which we pay — on personal property and real estate, Federal taxes and compensation to the city — as one of the most important in our business. In 1900 our taxes and municipal compensation amounted to $90,773. In the year just closed these items amounted to $968,262.

If you will make a comparison of our figures with those of other companies, I do not think it is stretching the facts to say that we have about a third more customers than the largest company of this country. We put out about a third more kilowatt-hours, and we receive for it about a third less dollars. I think that statement is the best that I can make as to what we are doing for the community in which we operate.

Remember, if we are looking for success, if we are looking forward in the future to greater increases in our business, to a greater security for the capital employed in it, we can only get that success and get that security by serving the community in which we live, fairly, honestly and economically. If we pursue the policy of dealing fairly with the community, I have no doubt that the figures that I have named will be far exceeded in the future, away beyond anything that we have expected in the past.

Possibilities of the Future

What I have had to say about the possibility of membership in this section of the National Electric Light Association and the fact that we probably pride ourselves a little too much on our

having the largest section applies equally to the business of the corporation for which we are all working. As near as I can figure, from the information obtained for me by our statistical department, the possibility of growth in the future is so great that I am inclined to think that our optimistic friend, the chief operating engineer, Mr. W. L. Abbott, will have to jack up his figures. I believe that if we had all the business that it is possible to do in this community at the present time with the present population that we have in this city, it would be quite possible to do a business of about 600,000 kilowatts of maximum demand. The field that is open to us today (and that is a subject which every one of you individually is very greatly interested in) is to my mind three times as large as the field we actually occupy. I do not mean to say that we can ever expect to get one hundred per cent of the possible business, but that ought to be the high mark, the goal which we should attempt to attain. If we ever can achieve that position, it will be greatly to the benefit of every one of you, just as much as it would be to the benefit of myself and those more closely associated with me, and just as much as it would be to the benefit of those who provide the capital, and provide it so liberally, to enable us to operate on the large scale on which we are operating in this city.

Labor and Capital Paid about Equally

That brings me to another subject, and that is, What becomes of the money that we spend? How much of it in the form of wages goes to you and to me and the other employees of the Edison Company, and how much of it, in the form of interest and dividends, goes to those who provide the capital to develop the business? Capital is entitled to its wages in the shape of interest and dividends just as much as labor is entitled to be paid in the shape of wages or salaries.

For the year ended September 30, as I have just told you, our total income amounted to $13,083,725. In the same time we invested nearly six millions of dollars in new plants. During

that time we paid out for labor directly from the company and through our contractors who do our construction work the large sum of $3,250,000. During the same period, we paid out for dividends and interest $3,114,000.

Now, if any one of you were proposing to start in business for himself, the class of business being such that the labor in it could all be performed by yourself, and if some capitalist came along and told you that he would provide you with capital, providing that you would take your pay in one-half of the profits and he would take his pay for the use of his money in one-half of the profits, you would consider that a pretty liberal proposition. That is practically the condition under which this great business is operated. On the one hand we have about 3,000 employees; on the other hand we have about seventy millions of dollars invested in our business. After paying operating expenses, that is, after paying for material, after paying about $1,400,000 for coal, about $1,000,000 for taxes and compensation and large sums for other classes of material, the employees receive about one-half of what is left — a little more than one-half. They receive $3,250,000. The capital employed in the business receives for its wages (and, as I have stated, money is just as much entitled to be paid its wages as labor is) a little less than you do; it receives $3,114,000. So you get about one-half of the net results.

Employees Should Study Economic Questions

Now, what does this mean? It means that anything that will work an injury to capital works an injury just as much to labor. I am inclined to think the figures that I am using would probably apply to every large electricity-supply company the world over. I think you will find that labor, as a rule, gets just about one-half of the net results. In other words, the capitalist puts his money into the business and he takes his pay in one-half of the profits, and he gives to labor the other half of the profits.

This should bring home to every one of us — not alone

to the president of the company, or the vice-president of the company, but to every man engaged in the organization, right down to the lowliest employee — the absolute necessity, if he wants to protect his own interests, of working in season and out out of season, not alone at his desk in the office, or in a generating station, or a substation, but everywhere he goes. If he wants to serve his own interests, or, to bring it down to a little more homely statement, if he wants to protect his own pocket, he should study the questions governing the control and the regulation of the corporation for which he is working. In work time and in play time he should do whatever he can to shape public opinion, to persuade others (as those who study inside the organization must be fully persuaded) that our policy, under all circumstances, is to try to do the fair thing and the right thing as between our corporation and the great community in which it is our privilege to do business.

SELLING OF ELECTRICITY IN LONDON AND CHICAGO COMPARED[1]

I FEEL somewhat embarrassed at the introduction that Mr. Byllesby has given me, because it would be natural to suppose that as I had made a special effort to be here this week (in fact, with great regret I left London a week ago last Saturday, when I had in mind the meetings here and the dinner later in the week) I had prepared a set speech. I have not done anything of the kind. I have been away on a holiday, and since I returned last Saturday morning I have not had a chance to prepare a set speech.

I was just leaving my friend Mr. Herman H. Kohlsaat, of the *Chicago Record-Herald*, at the lunch table, and I told him it was ten minutes to two o'clock and I had to start delivering a speech at two o'clock and I wished he would give me some ideas to talk on. The only thing he could suggest was, "Early to bed, and early to rise; work like Hades, and advertise."

Now you might ask, What has that to do with central-station business? If people go to bed early, perhaps they will not consume much electricity for lighting purposes. If you will get your business into the condition it should be in — it matters not whether it is in a large center of population, like New York, or Boston, or Chicago, or in a small center of population — you will be practically independent of whether the people go early to bed or not. That is our situation here in Chicago. Only 27 per cent of the energy that we put out is used for lighting purposes, so it is quite immaterial to us whether they go to bed early or not. We are somewhat interested in

1. Speech at the second annual convention of H. M. Byllesby & Company and affiliated companies in Chicago on January 18, 1911. In his introduction Mr. Byllesby said that Mr. Insull came from London for the especial purpose of attending the convention.

their rising early, because we want the load to start as early in the morning as we possibly can get it.

On the question of "working like Hades," any man who does not want to work — any man who is looking for the life of one "born with a silver spoon in his mouth"— had better get out of the operating side of the electrical business, as all such men have had to get out of the manufacturing side of the electrical business.

Value of Newspaper Advertising

On the question of advertising, my friend, Mr. Kohlsaat, had in mind his load factor; just as we all have in mind all the time our load factor. I do not know any better way to increase your load factor than by increasing the load factor of your local press by advertising very steadily. The result of daily newspaper advertising here in Chicago has been largely to increase the productive capacity of our canvassing force. It is an unusual thing for us to send a canvasser to visit a possible customer in the thickly settled portion of the city, unless that possible customer has either written us or telephoned asking us to send a man to see him. Of course, I do not refer to the larger business — the obtaining of big industrial power business, or the very large lighting business, such as shutting down an isolated plant; but I refer to the business obtained from house to house. We do not have to send our canvassers to-day to visit eight or ten houses before they can discover a possible customer.

Daily newspaper advertising, properly written, and persistently presented to the public, has had the result of so increasing the demand for our product that in the downtown district and the thickly settled residence districts our business is obtained from people who first invite us to call on them. You all know, as sellers of goods, whether those goods be electrical apparatus or the kilowatt-hour, that it is a great advantage to the seller to have the purchaser come to him first. So much for Mr. Kohlsaat's text for me.

Get All the Business in the Community

I have not any new subjects to present to you. I have simply the same story to repeat here that I gave utterance to at the last convention a year ago. One thing for you to aim at all the time is to produce all of the energy that is required in your community for whatever purposes that energy may be used; and in aiming at that happy result you, of course, have got to have a highly economical plant, which you certainly get with the engineering ability that is back of you in H. M. Byllesby & Company. You have got to quote prices based on the character of the service demanded of you, and thus invite that class of business that will lead to the best possible load factor — that is, the greatest possible average use of every dollar invested. You have got to get a bigger proportion of the business in the smaller cities; you have got to give really more attention to scientific methods of selling your product. There are less possibilities of obtaining business in the smaller towns and consequently you have got to get all the possible business in a given community.

It is an easy matter to handle these things in a very large city, and we who run the large companies, in talking to those who run the small companies, often fail to appreciate the greater difficulties that the people in the smaller cities have to deal with. I myself would fail to appreciate it if it were not for the fact that from time to time I have invested large sums of money in the development of small properties throughout the country.

Here in Chicago our maximum load this present winter is practically 270,000 horse-power. If we were doing all the business which it would be possible for us to do in this community; that is, if we could shut down all the isolated plants; if we could shut down all of the power plants operating industrial establishments; if we could shut down all of the power plants operating elevated-railway service; if we could transform the terminals of the steam railroads into electric operation over night and dispense with steam locomotives — it would be possible for us in this community to get a load, with the present

population, of somewhere between 750,000 and 1,000,000 horse-power. So you see we can afford to pick and choose our business. Even leaving out the electrification of the steam railroads, which, after all, would consume a relatively small amount of power as compared with the operation of the big surface transportation system in a large city — even leaving out the steam railroads, there is probably 750,000 horse-power of possible business within the city limits of Chicago. We do not have to persuade every man that our scheme of generating and supplying energy is the best and the cheapest. As long as we get every third man we can do a pretty good business and can employ about all the capital that we can conveniently raise from year to year.

Fixed Relation between Cost and Selling Price

But that situation, as I have said, does not exist in the smaller places. In order to reduce the cost of energy to the lowest possible figure, and consequently reduce your selling price, at a profit, to the lowest possible figure, you should have all the business in all the communities in which you operate. You should have the pumping of the water, the running of the street-car lines, the city lighting, the domestic lighting, the running of all the industrial establishments that you may have in the community — in fact, all the possible business in your community. And then, after you get that, you should go after the business in the next community, ten, fifteen, twenty, or twenty-five miles away, and by a further concentration of the manufacture of energy, reduce your cost, and consequently later on reduce your selling price. Because, after all, I care not, gentlemen, whether we are regulated by a city council, whether we are regulated by a state commission, whether we are regulated by that greater and still more potent force — public opinion — there can never be much more than about the same relation between the cost price and the selling price.

As rapidly as you are able to reduce your cost, either as a

matter of self-interest, or, if you can't see your own self-interests, then as a matter of compulsion — and, to my mind, proper compulsion — you will have to reduce your selling price. The chances are that for every saving that you can make in the cost of production — whether you get that saving from concentration of production for a number of small towns operated from one central plant, or whether you get that saving in cost of production from the concentration of the production of all of the energy required in a given community in one central station — you will have got to reduce your price. And it is very proper that you should do so.

What Might be Done in London

I do not know of any better instance of the opposite of what I have stated than what is still going on in the great city of London, or rather, I would say, in the county of London. The City of London has a very small area, only about a mile square. The county of London is more thickly populated, I think, than the City, because people do not live in the City; they go there for business. I think the county of London has a population of something like six or seven millions. In the county of London there are 63 different electricity-supply undertakings, either privately owned corporations or municipally owned plants, for the production of electrical energy. In addition, the underground railroads have their separate source of production, and the London County Council, which operates most of the surface transportation in London, has its separate source of production.

What is the result? With between six and seven millions of population, the output of electrical energy in the county of London is about 500,000,000 units (kilowatt-hours) a year. In Chicago, with a population of about 2,250,000, the output of electric units is about 700,000,000. The situation should not only be reversed, but instead of 500,000,000 units being produced and sold, or used for traction purposes, within the county of London, there should be at least three times that

amount, or upwards of double the amount of energy that we sell here in Chicago.

What is the reason for the difference? There is probably no better field anywhere in the world than the county of London for the economical production of energy, and its large sale on a wholesale and retail basis. Apart from the requirements in the ordinary everyday life of the six to seven millions of people, whether it be for transportation purposes or for lighting purposes, London is the center of a tremendous manufacturing interest. This fortunately, in some respects, for its inhabitants, is largely in the form of small manufacturing interests — a class of manufacturing especially favorable to the central-station manager in soliciting business. On account of the condition of the laws with relation to electric lighting and some conditions as to the acquisition of properties after the expiration of franchises, and some conditions which permit small municipalities within the larger area of London to do their own lighting business, they have a very high average cost, and consequently must have a high average selling price. I have not at hand the present cost within the London area, but the last time I made the comparison from official government returns a few years ago, the average cost of electrical energy within the area of London was about as great as the average income that we get here in Chicago, and we have to pay interest on our money and make profits for ourselves out of the price that we get for the electricity.

Don't Get Discouraged; Get the Business

Now, if that condition exists here, as to low cost of production and low selling price, and a volume of consumption fully forty per cent greater for a population of about one-third, the same conditions must exist in smaller places, if proper attention is not given to this question of the massing of production and of low selling prices. And let me tell you that low selling prices and massing of production mean a high earning capacity for the dollar invested.

The story I am telling is old — a story that you are all very familiar with. No one is more familiar with it than Mr. Byllesby. If I were looking for the fundamental causes of the success of H. M. Byllesby & Company, I think I would find it in the purchase of properties for which you have to pay good average prices, the consolidation of those properties, and, wherever it is possible, the massing of the production of the product which you sell so as to produce at the lowest possible selling price. As I have said, I have no new story to preach. It is simply to carry on the same work in the same way that we have been going for the last ten years, let us say, because, after all, the great impetus to central-station business has taken place since 1900. The great additions of capital invested in it and the stimulus that that has given in vast extensions of the business have all taken place in the last ten years.

The men in this room to whom I particularly wish to address my remarks are the men who feel discouraged at the results they are getting — the men who have low increases in their business as compared with previous years. These are the men that I want to reach. Of course, you may find in isolated cases that the fault is with the community — that the community does not grow. But I firmly believe that in ninety per cent of the cases where people fail to obtain success in our line of business, the fault is not with the material that you have to deal with — the fault is with yourselves.

Again let me appeal to the men who come here and see an enthusiastic, optimistic throng, and who fail to get rid of their pessimism while they are here. If you will go home and get all of the business offered in your community — and if you can't get it at one price I am sure the people in charge of operation in H. M. Byllesby & Company will authorize you to get it at a lower price — but get all the business. If you get all the business, you are bound to develop a successful concern and get a handsome return on the money invested in that business.

"SATISFY YOUR CUSTOMERS"[1]

PERHAPS it may be of interest to you if I draw somewhat on my experience of the last thirty years in the central-station business in addressing you this evening. The first central-station plant started in the United States was in the Central West, at Appleton, Wisconsin. I am under the impression that it was run from the water-power at Appleton, but of that I am not quite sure, as far as the first plant installed was concerned. That plant was started on April 20, 1882. I speak of it as the first central-station plant, because it was the first multiple-arc system started in this or any other country for the purpose of selling electrical energy to consumers in the same way that gas is sold to consumers over meter. The first large station started was in New York city a few days later — about fourteen days later than the one started at Appleton, Wisconsin. It had been installed by the old Edison Electric Light Company, the company that held the Edison patents, for the Edison Electric Illuminating Company of New York. If I am not greatly mistaken, your president, Mr. Byllesby, as one of the assistants in the engineering department of the Edison Electric Light Company, made the drawings for that first large central station started anywhere on either side of the Atlantic.

We people in the electrical engineering business have committed all kinds of errors, especially in connection with the mechanical engineering part of our business; but it is rather a remarkable thing that the first station of any magnitude that was built employed direct-connected units — of course not of the type that we are using at this time, but still with the

1. A speech, somewhat condensed, delivered at the banquet of H. M. Byllesby & Company and affiliated companies in Chicago on January 20, 1911.

dynamo directly connected to the shaft of the prime mover. Later, we strayed away from that method, but have come back to it as the true method of engineering in connection with our business.

Invaluable Assistance of Financial Houses

The days that followed the starting of the plant at Appleton, Wisconsin, and the plant on Pearl Street, in New York, were pretty dark days for the central-station business. It took a number of years to demonstrate the earning capacity that the business possessed, and instead of the business going ahead in the large centers of population, we were forced to look afield to the small towns of Massachusetts and Pennsylvania, where capital could be raised in small amounts, locally, for the purpose of establishing central-station plants. It was not until some years later that we were able to obtain the financial assistance of the large financial houses of New York, Boston, and Philadelphia; consequently there was some delay in establishing the large plants which we look upon today as more or less commonplace. And if it had not been for the very generous support accorded the business by such houses as Drexel, Morgan & Company of New York, I think that the development of the business would have been still further delayed. Those of us who have been in this business since its inception must have the warmest possible regard for the great financial house of which Mr. Morgan is still the head,[1] and which house rendered such marked and invaluable assistance in the development of the central-station business in this country.

Tributes to Westinghouse and Siemens

At the time the central-station business started we had to use lamps that consumed 6.5 watts per candle, and it was not until 1890 that we got the 3.1-watt lamp, and it was not until the last year or so that that great advancement was surpassed

1. Mr. J. Pierpont Morgan died on March 31, 1913.

by the invention of the tantalum, and following that the tungsten lamp, which have reduced the consumption of current so enormously as to bring our product within the reach, practically, of the poorest homes of the communities in which we operate.

The next great step after the invention of the three-wire system was the introduction in 1886 of the alternating-current system by the Westinghouse Company. I believe the first plant was installed by them at Greensburg, Pennsylvania ——

Mr. Byllesby: Great Barrington, Massachusetts.

Mr. Insull: Mr. Byllesby corrects me, and says that the first plant was installed at Great Barrington, Massachusetts; but I think these two plants must have been installed somewhere about the same time. I don't think it is possible for us to say enough of the wonderful service rendered this great industry by Mr. George Westinghouse and his associates in the work they did in connection with the introduction of alternating-current apparatus for use for central-station purposes.

The next great step was the building in 1890 to 1891 of slow-speed electric-generator units, this being the first step in the reduction of the investment costs of the central station, and also resulting in reducing the operating costs of the energy here produced. I am inclined to think that we have to go across the water for the first examples of this class of work; that is, the marine type of direct-connected steam generator outfits. We owe their introduction, if my memory serves me correctly, to the great house of Siemens & Halske, of Berlin. Especial honor is due to the great head of the house, the late Werner von Siemens, for his contribution to the inventive and engineering department of our business.

The introduction of direct-connected units of the marine type, with highly economical prime movers in the shape of triple-expansion engines, made possible and was followed in 1896 by the introduction of high-tension alternating transmission lines, operating substations. Direct-connected dynamo units of high efficiency, and high-tension transmission lines and substations forced an abandonment of small generating stations and compelled us to mass the production of energy on

a very large scale, either for the service in large cities like Berlin, New York, Chicago and Philadelphia, as well as the massing of production for supplying current to a number of smaller places, of which you have so many examples in the plants which you yourselves operate. The centralization of production and increased business demanded prime movers of greater size, lower investment cost and lower operating cost, which resulted in the development of very large steam turbo-generators, operating today in units of upwards of 20,000 horse-power; and within the next few months we hope to have operating in this city units of upwards of 30,000 horse-power each.

Central-Station Results in Chicago

The central-station business was developed at quite a late day here in Chicago. The company that was started at Appleton, Wisconsin, in 1882, was started by a merchandizing company which was the predecessor of the company here in Chicago of which I have the privilege to be at the head. It was known as the Western Edison Light Company. But that company confined its efforts for a number of years, from 1881 to 1888, to isolated-plant business, and it was not until 1888 that the first central station was started in this city at 139 Adams Street.[1] In 1892, which is the first year that I have any detailed records of, we had a maximum load of about 4,000 kilowatts. This present winter we have had a maximum load of over 183,000 kilowatts. So that you will see, over the period from 1892 to 1910, that our business has doubled on an average of a little better than once every three years.

Our coal consumption this year will be upwards of 1,000,000 tons; and if we used the same number of pounds of coal per kilowatt per hour as was used ten years ago, the coal consumption would be nearly three times that amount. Or, in other words, we have been able to improve the efficiency of our system practically 300 per cent in the period of ten years. I do not mean to say that that improvement has been entirely with the prime

1. See note on page 319.

mover. I am talking of the energy delivered to our customers. The fact that we have been able to bring about such a great improvement in ten years shows how materially the efficiency of our distributing system, as well as that of our prime movers, must have improved during that period.

Our experience here in Chicago is not peculiar to us. If the statistical figures of most of the companies which you represent had been carefully kept over the last ten years, you would find practically the same relative improvement in the plants in the smaller cities throughout the country. The progress which has been made, you may say, is marvelous. The real progress in our business has been all since about the year 1900. And I would venture to say, in looking at the matter from the point of view of the public, that nine-tenths of the improvements that have been obtained in that period have been given to the public and scarcely more than one-tenth has been given to those whose money is invested in the business.

The Question of Regulation

There are some pitfalls into which we may fall. We are engaged in a business which can be run on the most successful basis (that is, a basis which will give the lowest possible cost to the consumer, commensurate with a fair return on the capital invested) only as a monopoly business. I would venture to say that we cannot expect to enjoy the privileges of running a monopoly business, even if that monopoly be to the true interests of the community in which we operate, unless we are willing to carry the burden which must necessarily go with a monopoly; viz., the right on the part of the community, whether it be represented by local authorities or by the state authorities, to regulate the business in which we are engaged.

It is no new subject for me to deal with in insisting that a private monopoly must be accompanied by public control. I have preached that doctrine for a number of years, having laid it down as one of what I would suggest should be the cardinal principles of our business in an address I delivered before

the National Electric Light Association[1] in this city in 1898. I think the sooner we recognize that we are going to be regulated, and insist upon the protection that should go with regulation, the sooner we will get this question of dealing with the local public utilities settled. As Mr. Byllesby has put it, if we expose the innermost secrets of our business, we should be protected in the enjoyment of a monopoly. In most of our states today it is a political question. It should not be a political question. And if we use our endeavors to bring about a settlement of this question, it will cease to be a political question, and will get where it belongs, namely, into the class of economic questions which will not permit of any politics being in it at all.

The question of influencing public opinion on this subject rests with you gentlemen sitting around the tables here. Those of us who direct the policy of large enterprises can do but little unless we have the assistance of the men who are operating the plants and coming in contact with the public from day to day. And I know of no qualification so necessary in our business — I will put it before engineering ability, or technical skill, selling ability, or any other line of business ability — as the ability to deal in a satisfactory manner with the people with whom you come in contact from day to day.

Great Questions of the Future

If you were engaged in the mercantile business, one of the first things you would want to do would be to satisfy your customers. And that necessity is far more and far greater in our business than it is in the mercantile business. We have to deal with the whole community. The feeling of that whole community toward your business, if it be good, is a valuable asset to your company. The feeling towards your business, if it be unfriendly, means disaster to the investment you have in your care.

I think that our future rests very largely with ourselves.

1. See "Standardization, Cost System of Rates, and Public Control," page 34 et seq.

If we cannot operate our business in a way to earn the respect of the community in which we work, there can be but one outcome to our business, namely, failure.

I might go on talking to you for a long time, not only on the question of pitfalls, but on the question of the possibilities of our business. If you were to recall the facts you would find that not more than twenty-five years ago there was less than $10,000,000 invested in the central-station business, and that today there is upwards of $1,250,000,000 invested. The possibilities of the next quarter of a century are far greater than those of the last quarter of a century. We have nearly perfect apparatus. We have relatively cheap money that can be obtained for investment in our business. We have low operating costs, and we have before us the possibility of producing all of the energy required in the communities in which we operate.

A very remarkable address on the possibilities of the central-station business was delivered at the last inaugural meeting of the Institution of Electrical Engineers in London by Mr. de
4 Farranti, the new president of the association, and who was one of the pioneers in our business in the development of large centers of production and large areas of distribution. Mr. de Farranti addressed himself to the question of conservation of the fuel resources of Great Britain. The very life-blood of Great Britain is its coal supply. The only way that country can keep the mastery of the seas is by the preservation of its highly economical coal beds. Mr. de Farranti sketched out the plan of dividing England, Scotland and Wales into one hundred districts, and producing all of the energy required for all kinds of purposes—lighting, power, heating, and transportation—all from these hundred centers of production. I have not in mind the saving which he said would be effected by the lessening in the consumption of coal, but it was somewhat on the lines of the reduction that you and ourselves have been able to bring about in the consumption of coal in our various plants in the last ten years.

So that to my mind, instead of our field narrowing, it is

going to broaden from year to year. When the great railroad systems of the country come to the conclusion that it is time to electrify, they should be able to obtain that energy, from the shores of Maine to those of California, from the central-station plants existing at the time they want to make that change. And I might say that that great step in connection with our business, viz., the electrification of the steam terminals of the country, and possibly later of their main lines, would be in a far better position today if the two great transportation companies centering in New York which have electrified their terminals had bought their electricity at rates at which you and myself and others are very willing to sell energy to the transportation companies in our particular communities.

RELATIONS OF THE PUBLIC TO THE PUBLIC-SERVICE CORPORATIONS[1]

TO MEET the members of the Chicago Engineers' Club is a great pleasure. I take a lively personal interest in your profession. Most of whatever success I have made, and I might add not a few of the failures I have made, have come to me from my connection with the fraternity to which you gentlemen belong. A great many of my pleasures, and not a few of my worries, have been caused by the engineering profession, and therefore it is a pleasure to me to come in close contact with you and to talk to you on a subject, which, although somewhat technical, I can presume to talk upon in the presence of engineers. It is an especial pleasure to me, because it often happens that when I am talking to engineers I can see in their faces the suggestion that it is somewhat presumptuous for a layman to talk to them on engineering questions or on technical questions.

Now, as to the relation of the public-service corporation with the public. When Mr. Heyworth[2] asked me to address you, I hardly knew what branch of the business with which I am connected I would like to talk about, and therefore I made the subject as broad as possible; and you must excuse me if I seem to confine myself to some of the details of the question, and not deal with it as a whole.

The first essential of a public-service corporation in bidding for success is to give the very best of service at the lowest possible price. It matters not whether that public-service corporation be a local one, located in a city like Chicago, or

1. An after-luncheon speech before the Chicago Engineers' Club on January 24, 1911.

2. Mr. James O. Heyworth, then president of the club.

whether its business embraces a state or a series of states. If a public-service corporation expects to bid for public favor — and if it does not get public favor it might just as well go out of business — it must give the very best possible service, with the very best possible apparatus, at the lowest possible price, considering the price that is to be paid for money in the markets of the world and considering also what you have to pay for labor and the amount of depreciation on the plant that you are dealing with.

The Best Service at the Lowest Price

We have had in this community cases where public-service corporations have lost the good opinion of the public, largely on account of their failure to give first-class service, that failure sometimes being due to conditions over which those public-service corporations had little or no control.

Take the business which it is my privilege to manage in this community. We endeavor to give the very best possible service we can at the lowest possible price. The public has a great deal to do with bringing about this desirable result. If the business of the production and sale of electrical energy is to be carried to the greatest possible success, that is, its production at the lowest possible cost, with the product sold at the lowest possible price having in mind a reasonable profit to the investor, that business must be a monopoly business. It is a waste either of the money of the investor, or the money of the customer, or in some cases the money of the taxpayer, if any attempt is made to operate the business other than as a monopoly business.

That is what I mean when I say that the public has something to do with getting the best results in the running of such a business as that in which I am engaged. It matters not how economical may be our apparatus, how advanced our engineering, how good the management of our business, if the public decrees through its proper representatives that somebody else by the side of us shall deal in precisely that same line of busi-

ness, shall have a duplication of our plant and a duplication of our service, the results from an economic point of view must be bad. The people who have to pay for it are those who buy our product.

This question of economy of production does not mean merely the production of energy for lighting purposes, but energy for every purpose that it can be used for in the community. It matters not whether it is for transportation purposes, for manufacturing purposes, or for the hundred and one processes in the industrial life of the community, if you are to get the very best possible results, the entire production of a given area — not necessarily of just one city, but of a given area of country — should come under one head.

Boldly Preaching the Doctrine of Monopoly

In other words, I am here boldly preaching monopoly as an economic proposition in a day when our public men look more or less askance at the idea of monopoly. And I preach monopoly because it is the only possible way to get the results. It is on account of our enjoying a practical monopoly in this community that we are able to sell more electricity than is sold in any other community in the world; that we have more customers who buy our product than is the case in any other city in the world, and that the average price at which we do the business is lower than in any large city either on this side or the other side of the Atlantic.

The statements that I have made may seem somewhat egotistical; but I think you will find that they are not far-fetched, if you will look into the figures with relation to the output of electrical energy and prices at which it is sold in the various large cities either in this country or abroad.

In order to do these things we have to have a good deal of energy, and before passing into the larger subject of public-service corporations as a whole in this community I will give you a few of the figures with relation to our own business.

We have upwards of 125,000 customers. I think that is the

largest number of customers of any company in the electricity manufacturing business. Our maximum load this present winter has been up to date 275,000 horse-power. Our output for this year will be about 25 per cent greater, with a population of only two millions and a quarter, than the output of electrical energy in the county of London, with a population of more than seven millions of people. Our cash investment is about $70,000,000. Our business doubles every two and a half years. I do not mean to say in money figures, but I mean to say in the energy that we put out; about every two and a half years our business doubles, whether measured by the amount of our maximum load or the amount of our steady, daily output. Our coal consumption is upwards of a million tons a year, increasing now at a rate in about direct proportion to the increase in our output. Our pounds of coal per unit sold are about a third of what they were seven or eight years ago. That improvement in efficiency does not come entirely from the prime movers; it comes partly from our distribution efficiency; that is, the higher efficiency of our distribution systems.

Duties of Citizens to Public-Service Industries

Speaking of a million tons of coal, when you bear in mind that that is upwards of ten per cent of the entire soft-coal consumption in this city, it will give you some idea of the problem it is to handle merely the fuel consumed from day to day. It it no uncommon thing for upwards of two hundred tons an hour to pass over our grate bars during certain hours of the day in the winter, and we have to do that to produce the energy and yet come within reasonable reach of complying with the demands of another engineering body, the Smoke Abatement Commission.

I mention these figures with relation to the business which it is my privilege to run to give you some idea of the magnitude of the public-service business in a community like Chicago. The serious point, to my mind, from the point of view of a

citizen of this community, is not so much the relations of the public-service corporations to the public, but the relations of the public to the public-service corporations. That, I think, is really the most serious situation that exists in this community with relation possibly to any local business.

The cash invested in the local public-service business—that is, telephone, gas, surface and elevated urban transportation, electric light and power, and exclusive of the urban and suburban transportation of the steam railroads—amounts to between $450,000,000 and $500,000,000. Just pause a moment and think of the stupendous figures. I am not talking securities; I am talking money. The estimate given is, I think, a fair approximation of the amount invested in all of the local public-service businesses in this community, with the exception of the large urban and suburban and interurban steam-transportation businesses connected with Chicago, which of themselves, apart from the trunk-line business of the steam railroads, must represent an enormous additional investment.

The gross earnings of these properties is somewhere between $75,000,000 and $80,000,000 a year.

The expenditures for extensions and improvements during the last three or four years have been somewhere between $35,000,000 and $40,000,000 a year, caused somewhat by the extraordinary expenditures of the two main companies operating the surface lines on account of their rehabilitation. But I think when you figure the growth of the city and the fact that in hardly any department of public service has the point of saturation been reached, the least possible figure that can be put down as that necessary for future development is about $25,000,000 a year.

The total number of employees in the local public-service businesses of this city, leaving out entirely the steam-railroad employees, is nearly 50,000. If you figure five to a family, you will find that nearly ten per cent of the population of this large city is dependent for its daily bread upon the prosperity of the public-service corporations of this community. I therefore say that with these figures before us, considering also the

enormous capital investment employed, the millions expended from year to year in improvements and extensions, the tremendous disbursements in wages (disbursements to labor exceeding, probably, the profit which capital receives for its money), we may realize that one of the most vital questions, one of the most serious questions, to a community like Chicago, is its relation with the public-service corporations. It is apparent that unless the policy of "live and let live" is developed and maintained with reference to the public-service business it does not seem an unreasonable statement to make that failure of the public-service corporations in this community must have a very serious effect upon general business conditions in this city, and upon the interests of a large portion of those who live here in Chicago.

If you add to the number of employees of the local public-service corporations those of the steam railroads centering here in Chicago, I think it would be no unreasonable statement to say that upwards of twenty per cent of the population of this great community is dependent upon local and state and interstate public-service business for a livelihood.

Clamor and Guesswork Do Not Promote Industry

In closing I do not think that I can do better than read a quotation from one of the leading articles in the *Chicago Record-Herald* of December 30 last, as a means of impressing upon you my point of view with relation to the importance of these great industries to this community. The question under discussion was regulation — of telephones, I think — and the writer finished his article by saying:

"To make gas, telephone, water transportation or other rates footballs of party or factional politics is to make honest government and honest service of the public very difficult, if not utterly impossible. Clamor and guesswork may suit office seekers, but they do not promote industry, good government, or civic peace and justice."

In urging on you gentlemen the extreme importance of

the public-service industries to a community like Chicago I do not want you to go away with the impression that I do not think monopoly industries should be regulated, or that they should be allowed to go along in their own sweet way, enjoying the privileges of their position, and not accepting any of the obligations. I am a strong believer in proper government regulation of all such enterprises. I care not whether they be local, state, or national.

But I do not believe that those enterprises should be regulated by government as a matter of political expediency. I think they should be regulated and governed on a basis of what is economically right, what is economically fair, what is just to the user, the consumer, and what is just to the man who puts up the money, the capitalist. On that basis, I am a very strong believer in regulation and control. In fact, I have been advocating it in my own line of business now for between fifteen and twenty years. When we get to a point that these various public businesses, as I say, local, or state, or national, are regulated on purely economic lines, you will find that the consumer will get more satisfactory service, that he will get it at a lower price because money will be cheaper, and that the situation will be better all the way around. It is the only way that you can really remove these things from politics.

VALUE OF COMPANY-SECTION ORGANIZATION IN THE NATIONAL ELECTRIC LIGHT ASSOCIATION[1]

IT IS rather to be regretted, I think, that there are not more representatives here this afternoon from companies that have no company sections. I consider that when Mr. H. L. Doherty made the suggestion that we should establish these company sections he rendered a great service to the industry; that is, not only to the association but also to the companies themselves. Naturally, I look at this matter from the point of view, to use the expression of this morning, rather of the "master" than of the "man," although I try whenever I am looking at things from that point of view also to view it from the "man's" point of view.[2] I consider that from the company's point of view it is one of the most desirable things that has been brought into our business. I know of nothing that contributes so to *esprit de corps* in an organization, that results in so close a feeling of relationship and loyalty to the organization, as the establishment of these company sections. It is much to be regretted that the greater part of the company-section membership is confined to five or six of the larger companies. It is a class of work that can be extended right down to the smallest organization, the smallest electric-lighting company that has membership in the national organization; and I think that if we want this organization of ours to maintain its virility we have got to look to the company sections to accomplish that.

1. Remarks made at the company-section session of the National Electric Light Association at the convention in New York on May 30, 1911.

2. Referring to a paper entitled "Master and Men," by Mr. Paul Luepke, of Trenton, N. J., read at the morning session.

I think we should work at some scheme that will get representation of company sections at the national convention.[1] We tried to do it, indirectly, in Chicago (just as Philadelphia has tried to do it by one scheme and another) by bringing some of our company-section members here.

However desirable it may be to have close relationship between the company sections and the employees, say, of the electrical contractors or allied industries, I am inclined to think that it would be a misfortune to the company sections connected with the National Electric Light Association to admit the employees of those concerns, as the result might be a repetition of the unfortunate relationship that originally existed between the supply people and the manufacturers in the national organization. What we want to do, and what we want to do just as much for the benefit of the employee as for the employer, is to bind our people close to us by whatever method we think will bring about that result. I know of no method that will bring about that result so well as by educating the foreman of the linemen and fitting him to occupy an executive position. It has been done in the steam-railroad business very extensively, so that today I think you will find that the greater part of the trunk lines of the country have as their executive heads men who have worked in section gangs when they first started in the railroad business. There is no reason why we should not bring about that same result in our business. I know of no better way of doing it than by the encouragement of company sections among all of our company members, and I think that the main effort of the next administration should be in the same direction as the fine efforts made by Mr. Freeman and his fellow officers during the last year in encouraging the company-section membership. If the work is followed out, we will have a very large number of these sections, and they will be of great benefit alike to the companies and to their employees.

While I appreciate that you cannot get men together in a

1. Mr. Insull's idea was carried out later, at least partially. At the Philadelphia convention of the National Electric Light Association, on June 3, 1914, a meeting of company-section delegates was held. The association has now (March, 1915) a standing committee on company sections.

room, say once a month, who have been hard at work all day unless you provide them with some form of entertainment, I think there should be some continuity of policy as between the executive officers of this organization and the various company sections throughout the country. I think there ought to be a proper exchange of all classes of information. I do not know exactly how it could be worked out most economically, because, after all, all these things cost money. While we have a large and influential organization and can raise considerable amounts of money for special purposes, the regular income of the association is ridiculously low, if you look at it from the point of view of the importance of the organization. But there ought to be some method of exchanging the ideas, exchanging the papers, and insuring continuity of policy.

A subject that we are all of us vitally interested in, that affects our very existence, is our relations with the public. We are subject to all kinds of attacks. It has been stated that we have, say, about 65,000 employees of the member companies of this association. I think that that is a low estimate. I think that a fair estimate is nearer 100,000 employees. The experience of Brooklyn, New York, Chicago and Philadelphia shows that we can count on about 40 per cent of our employees becoming members of the company sections. Suppose we have 100,000 employees in various parts of the country — nay, as we are reminded by the flags[1] that it is my pleasure to see, they are on both sides of the line. What would be the effect on public opinion if, say, 40 per cent of that number had a proper understanding of the questions governing cost and selling price, of the relations of capital and labor, of the relations of the community to our business, of the serious effect upon the cost of our product to our consumers if we suffer from adverse legislation and cannot obtain money at a fair price? Questions of that kind could be discussed in our company sections. It can be done by the men inside the organization perhaps. Or

1. The room was decorated with the national colors of both the United States and Great Britain. The "line" of the text is, of course, the international boundary between the United States and Canada.

there are many men throughout the country who are very glad to give their time to enlighten us and our employees on those subjects. Again I repeat that it is of vital importance alike to the National Electric Light Association and its company members and their employees to push this movement to the greatest possible success.

THE FINAL TEST OF WELFARE WORK[1]

WHILE a number of the members of our association have done a great deal in connection with welfare work, it is perfectly natural that in a business which has grown in a little less than three decades to the enormous proportions which the electric-light-and-power industry of today shows our attention should have been devoted more especially to matters of new invention, improvements in efficiency of apparatus, and improvements in the method of conducting our business. In passing it might be well to mention that, notwithstanding all of the work we have bestowed on these various subjects, the savings accomplished—that is, in dollars and cents—have in the main gone to our customers, the consumers of electricity throughout the country, to an extent probably of from 90 to 95 per cent.

The question of our relations to the public, to the communities in which we do business — the view taken of us by those we serve, our customers — is a subject to which we have given a great deal of attention in the past, and will be forced to give a great deal of attention in the future. But I know of no subject that will bring us greater return —in speaking of greater return I am not speaking of the money return — I say I know of no subject that will bring us greater return than to devote our attention to the welfare of those who work under us.

1. Mr. Insull has been deeply interested in welfare work for many years. This subject, with various aspects of public relations, is considered in the National Electric Light Association by the public policy committee, which is the most influential committee of the association. Mr. Insull has been a member of this committee ever since its organization. He has presented its reports at the annual conventions of the association for a number of years. This was the case at the brilliant gathering at the New Theater, New York city, on the night of May 31, 1911. The report of that year related principally to relations between capital and labor. After reading it, Mr. Insull added, on his own account, the remarks reported here. See also "Broad Questions of Public Policy," page 405.

None of you in this room can fail to appreciate the fact that one of the greatest pleasures that can possibly come to men who have the responsibility of directing large enterprises is not that of merely making money for their stockholders and themselves, but the pleasure that comes to them from the opportunities they have to do good to their fellows. They want to try to leave the world a little better off when they leave it than when they came into it.

While the altruistic side of this work is very inviting, yet there is another side to it which we have to consider; namely, the financial side. We are engaged in a monopoly business, and it has to be operated economically to the best interests of the users of our service. We must adopt such methods as will enable them to get the service we render for the least possible price so as to stand the scrutiny of such regulating body as we may be subject to. The regulation of our rates may come in the shape of action by a board of aldermen, or it may come in the shape of action by a state commission, or it may come in the shape of action by legislatures having the power to deal with matters, or it may come in the shape of an appeal to the force of public opinion on account of the unreasonableness of our rates.

All of us, in one form or another, are subject to regulation. The real final test of this welfare work will come when we propose to include all the various matters, or most of the various matters referred to in this report, in the cost of service, and consequently the selling price, to our customers. This price has to be passed on finally by whatever regulating body it may be our particular good fortune to come in contact with.

I know of no business where continuity of service is of such great importance as in the business in which we are engaged. It is a business of great capitalization in proportion to the yearly return. It is impossible to run it satisfactorily so as to turn over the cash capital more than once in five years. There are very few instances on either side of the Atlantic where such a result has been obtained. The consequence is that our interest account and our depreciation account are of much greater importance than our wage account. What we need in

order to keep down our interest account and our depreciation account is continuous and faithful service. That can be obtained only by offering some incentive beyond the mere wage which every laborer and every man who works with his hands or with his brains is entitled to.

The subjects that we deal with in this report are not our subjects merely. We are not alone in this work. Most of the great industrial corporations in this country are giving a great deal of thought and attention to these matters. As a result they are giving substantial aid to the welfare work in connection with their employees, largely for the same reasons set forth in our report and the reasons I have set forth in my remarks.

If you will look into the progress of this matter in other countries you will find that a great deal is being done in the direction of governmental assistance and legislative action. Take, for instance, the drastic Employees Liability Act passed a year or so ago in England, or the Old-Age Pension bills passed in England and Germany, or Compulsory Insurance, with all its complex details, now proposed by the British Chancellor of the Exchequer. These are examples of a species of governmental paternalism, certainly with relation to the old-age pensions and compulsory insurance, which can hardly find any favor in this country. It seems to us of the public policy committee that it is far better that such work, in this country at least, should be done voluntarily, based upon the mutual interest of the consumer, the employee, and the capital invested. That is the work we are hoping to start here tonight among those of you who have not taken the subject up. We do not want you to think that it is necessary in every case to carry out all the plans suggested in the report.[1] That is not a possibility in a great many cases.

It is to be hoped that every one of you will apply to your particular case at least one of these schemes,[2] or some other

1. The full report is printed in Vol. I of the Proceedings of the National Electric Light Association for 1911.

2. Relating to such subjects as accident insurance, sickness insurance, death benefits, service annuities, profit sharing, employees' savings and investment funds, and life insurance.

scheme; and if you do it you will improve your relations with your employees. I am confident it will improve your relations with the public and will add to the stability of the securities of the business in which you are engaged.

THE NECESSITY OF THE APPRAISAL OF PUBLIC-UTILITY PROPERTIES[1]

MR. BYLLESBY has dealt with the subject of the appraisal of our properties in a very able way from what I might call the professional or engineering point of view. My connection with such matters is more particularly with the financial side of the subject, with the capital side of the question. In discussing this subject with members of this organization, what impresses me more than anything else is how few of the managers of electric-light companies have a correct appreciation of the real capital invested in their business, and consequently the value of the property they are running.

Since I have been here this week, one gentleman has asked me what I would do in a case where the actual value of the property was away below the amount of securities outstanding, and it occurred to me to ask him the amount of his income. My recollection is he said $140,000 or $160,000 a year, gross. I then asked him what his capital was, and he said that the bonds which had been issued were away beyond the value of the property; the company had issued bonds for $550,000. Now it is just as impossible for a man to do $140,000 or $160,000 of gross business with less than a cash capital of from $700,000 to $800,000 as it is for me to fly to the moon.

The best investment that any of you can possibly make is to find out where you stand. You are in the habit of taking stock of material on hand; now take stock of the property you have. Do not attempt to do it yourselves, because you have

1. Mr. H. M. Byllesby, of Chicago, read a paper on "Breadth of View in Public-Utility Appraisals" before the National Electric Light Association at the New York convention on June 2, 1911. In discussing this paper Mr. Insull spoke as reported here.

not had the experience that will enable you to form a correct conclusion. I am practicing exactly what I preach. If I want a valuation of the Commonwealth Edison Company's property, I do not go to my engineers and auditors, or to the heads of my various departments, but I call in an outside expert, and I pay him his fee to tell me exactly the value of the property I am operating.

In dealing with the question of rates, in dealing with your relations with the community in which you do business, in dealing with your relations with different governmental bodies, if you know exactly the value of the concern you are running you will find that you can make a trade that will give you a satisfactory return on the capital invested. I would like to talk on this subject all the afternoon, gentlemen, because I cannot say too much to impress you with the necessity of a proper appraisal. It is not a cheap operation. You will think you are spending money that makes your profit-and-loss account for that particular month when you pay the bill look very sick; but the very best investment that you can possibly make is to find out just where you are. In the great majority of cases — I would say in almost all of the cases of the properties represented in the membership of this organization — you will find that you have greater values than you have thought. Take the case of the gentleman just cited. He thinks he is in a very bad hole. He thinks that with an issue of $550,000 worth of bonds it is impossible to find $550,000 of property, and yet I know, as well as I know that my name is Insull, that he has actually between $700,000 and $800,000 of property, without valuing the business as a going concern.

CANADIAN ELECTRIC-SERVICE PROBLEMS DISCUSSED ON CORONATION DAY[1]

IT IS not only a pleasure but a very great privilege to me to be present on this occasion, and to be permitted to address you on so important a day, a day of such consequence to all English-speaking people, as the Coronation Day of King George V. I had expected to have a little celebration of my own on this occasion on a farm on the prairies of Illinois. That my arrangements, owing to your kindly offices, should have been changed so that I am allowed to spend Coronation Day on British soil is an honor that I shall very long remember.

It is not the privilege of all Englishmen who seek their fortunes beyond the sea to follow the "all-red route," or to live under that "little rag of red," but wherever they may be, although owing to the exigencies of business they may live under other flags, I think as one of them I can say that they never forget the Mother Country. Whatever duty and loyalty they may feel to the flag of their adoption, they still have (and the older they grow the stronger the sentiment) a great pride in the traditions of Britain's past, and in the greatness and achievements of herself and her children of the present. We have the greatest possible sympathy for her in the time of her troubles, and the profoundest belief and confidence in the great future that lies before the English-speaking people who owe allegiance to the British flag.

I have been particularly impressed with the character of your meetings. Nothing can be of such great benefit to the industry in which we are all engaged, nothing can be of such great advantage to the Canadian portion of that industry, as

1. An address delivered at the annual dinner of the Canadian Electrical Association in Niagara Falls, Ont., on June 22, 1911.

an association such as yours, with deliberations such as it was my pleasure to listen to this morning. For a number of years it has been my privilege to take an active part in the affairs of the National Electric Light Association, and I would like to refer for a few moments to the work of that association, with which you have become recently more or less affiliated, and tell you some of the things that that association has done for the industry on the other side of the Gorge.[1]

BENEFITS OF ASSOCIATION

In speaking of the subject I want you to bear in mind that I am speaking from the point of view of a man responsible for the investment of large sums of money in electrical enterprises, and therefore as one who is forced to consider whether associations of this kind are likely to be of material benefit and of financial advantage to the various companies such as you gentlemen are connected with. It is my judgment that the work of the National Electric Light Association has done more for the improvement of the commercial methods and the engineering methods of the electrical industry in the United States than any other one agency since the early work of the inventors who first gave us the various electric-light-and-power systems which we are engaged in operating.

This association has done much in the way of fostering pleasant relations between our various member companies and the communities in which they do business. It has added very largely to the knowledge of our employees, and consequently has added very much to their efficiency. We are now engaged in endeavoring to introduce schemes among our member companies with reference to such things as pensions, savings funds, insurance, and the like, for the purpose of adding to the material welfare of the employees of the various companies which are members of our association.

The business in which we are engaged has few parallels in

1. Referring to the international boundary between the United States and Canada.

growth in the industrial world. Three decades ago there was scarcely more than a few hundred thousand dollars invested in this business, and today there is probably $1,750,000,000 invested in the electric-light-and-power industry in the United States and Canada. There are probably employed by the various companies from 100,000 to 150,000 men. Notwithstanding its remarkable growth, the business has, on the whole, paid handsome returns on the capital invested.

It is a business which is probably less affected by panic and industrial depressions, which we must expect from time to time, than any other public-service industry. This may be partly owing to the fact that we are engaged in a new business, and that we have not reached the point of saturation, our efforts to extend our operations being somewhat sharpened when we find periods of depression in general business approaching.

Hydro-electric and Steam Production Compared

Being at this location, right in the center of what is popularly supposed to be the greatest power development on the North American continent, naturally one would refer to the question of hydro-electric development; but it happens that practically my entire experience, with the exception of a few isolated cases, has been confined to steam development. Sometimes I wonder why it is that the public, whether they are in Canada or the United States, look upon Niagara as the greatest power-production center in this country. My own impression is that the greatest power-production center in the United States, at the present time, if you include all the various electric-light-and-power companies and transportation companies, is in the city of New York. With all modesty I may add that I think the largest steam-electric power-production center in the United States operated by one company is probably that of the company of which it is my honor to be the president in the city of Chicago.

There are a number of gentlemen in this room whose business is menaced more or less by the hydro-electric development on

the Canadian side of the Niagara River. I want you when you go home to figure out what is your investment per kilowatt of maximum output and divide that investment into two classes, one the generating investment and the other the distribution investment. You will find that your average investment — and I do not think that the proportion is any different in Canada from that in the United States in this respect — you will find your average investment in the distribution system is just about five or six times your average investment in your generating plant. So when you hear that Niagara power is coming into your territory, and that the investment for the production of Niagara power is apparently some absurdly small sum per kilowatt of maximum output, please remember that before that hydraulic development can be used to any extent in your community it must be accompanied by exactly the same amount of dollars invested in distribution system that you have. Your case is by no means so hopeless as would appear if you just take the information on the surface — the apparently correct information — and do not go to the bottom of the thing. I suppose some might consider that what I am about to say is a wild statement to make; but I have thought for a good many years past that a steam-generating plant located in the city of Buffalo could compete under the conditions under which energy is sold in Buffalo, and must be sold, owing to the conditions under which business is done, and the conditions under which people live, and so forth; I have thought that such a plant could compete with electrical energy brought from one of the water-power plants here at Niagara Falls.

Opportunities for Young Men

Before I take my seat I want to address a few remarks to the young men here. I want to say to the young men attending this convention that I know of no business which has so great possibilities for advancement and for an honorable career as the business that we are engaged in. Some might say that it is natural that I should make such a statement because I

know of no other business; but speaking from my own experience, and speaking from the experience of a great many young men who have grown up with me in this business, a great many men who today are looked upon more as the fathers than the sons of this industry, I say I know of no business that affords greater opportunities for you young men. The positions that you can achieve, the advantages that may accrue to you in the business, rest entirely with you. You have before you the opportunity to obtain the knowledge to fit yourselves to occupy positions of prominence in this industry, and naturally those positions must bring with them the advantages and the emoluments that come with prominence and come with success. It is simply a question whether you will rise to the occasion when it is afforded to you and whether you will grasp the opportunity that is before you. Whether you are in a small country town or in a large city you should take advantage of the opportunity to gain a knowledge of the business that is right at your hand. I know of no better agency to get that knowledge of your day-by-day work than by forming a connection with such an association as yours or the National Electric Light Association. I know of no place where you can get better engineering knowledge, better commercial knowledge, better advice as to what to do under all kinds of circumstances, than you can get from the National Electric Light Association and its affiliated body, the Canadian Electrical Association.

To those gentlemen here who are responsible for the operation of properties I want to say that they cannot spend their companies' money to better advantage than by sending their young men to meetings of this association, if the meetings are of such a character as the one I attended this morning. In offering them that advice I am only practicing what I preach, and what is practiced by the managers of all the large electrical properties of the United States. The only limit as to the number of the men that we send to our conventions, and the only question that we consider at convention time, is how we can get along in our business with such a number of men absent.

Public Opinion Cannot be Neglected

The question of the relations between the public-utility operating companies and the communities in which they operate has been much discussed in the last few years. The old method of doing business was to assume that the public utility belonged to a class of overlords that could not possibly make a mistake. If the community in which it operated was not satisfied with its methods, why the people must just put up with those methods just the same. I care not how good may be the franchises under which you operate, how long may be the grants you have, how able may be the management of your property, so far as the engineering side of it is concerned, or how good may be your engineer and how perfect your plants, unless you can so conduct your business as to get the good will of the community in which you are working, you might just as well shut up shop and move away.

This matter of public relations is one that has been brought home to a great many industries, not only public-service industries, but all classes of industries in the United States in the last few years, and I think you people on this side of the line might very profitably study what has been going on in connection with public opinion in the United States, and the relation of public opinion to corporate affairs. Most of the troubles that have occurred in the United States found their origin in an absolute neglect of public opinion in the case of general industrial corporations and a neglect of local good will on the part of the local public-service corporations.

Having obtained a franchise, if you are men dealing with the public from day to day, the first thing you want is the public's good will. If you are managers of properties, the first thing you want, on the part of your employees, is to see that they do everything to get that good will. I do not mean to say that you should give way to every whim or caprice, or that you should bow to every demand of the politician who is bidding for public favor. That is not at all necessary in order to get general public good will. You have to remember, as one of

your members stated in a paper this morning, that the community is your customer, and you have to put yourselves in the position of your customer.

Suppose one of you went into a store to make a purchase, and you wanted some certain article, say an article of apparel, of a certain color, say white. What would you think if the clerk behind the counter reached up for a roll of goods and said, "Well, our rule is you have got to take green." You would walk out and go somewhere else. You would buy the white article at some other place. There are many things that public-utility companies do that are just as absurd as that. My last word to you is that above franchises, above all question of money making (because customers' good-will will help you to make money), above all questions of engineering, consider your relations with the community in which you are working and in which you have got to live, because your plant cannot be picked up and moved away.

DUPLICATION OF PRODUCTION IS ECONOMIC WASTE[1]

WHILE sitting here and listening to my friend Dawes[2] I began to get very pessimistic about the possibilities. But he made one remark that I think should give us some hope. He stated that public-service business is recognized as a monopoly, a regulated monopoly, and that therefore we who are engaged in operating public-service industries are not subject to attack to the extent of competitive industrial organizations; that it is easier for us to get capital to flow into our coffers. This is the first time that I ever had a banker tell me that. Mr. Dawes went on to say that we have not the trouble that ordinarily exists in the large industrial enterprises in this country. If he had been in the public-service business as long as I have, he would probably recall the fact that some twenty years ago the cure offered for all the ills that the public suffered from in dealing with public-service corporations was competition. That would fix up everything. If the authorities would only grant new franchises, start a new gas company, or a new electric-light company, on a competitive basis, that would regulate the situation.

Those of us who are in this room and who were in the business, as I was, twenty years ago, will recall the fact that we challenged that dogma. We took the position that competition in public-service business was a waste of capital.

1. During the annual convention of the American Institute of Electrical Engineers for 1911, which was held in Chicago, Mr. H. M. Byllesby gave a dinner at the Chicago Club to which many of the prominent engineers attending the convention were invited to meet several men of note in Chicago banking and business circles. Mr. Insull spoke at this dinner, and this chapter is a report of his speech on that occasion. The date was June 29, 1911.

2. Mr. Charles G. Dawes, president of the Central Trust Company of Illinois.

That in addition to its being a waste of capital, it was a charge against the consumer, because capital always gets its pay. We came out boldly and took that position and we won out. There is some hope for the industrial corporations if they will find and take the correct position in relation to their business. They may win out.

It is a very great pleasure for me to have had the Institute visit Chicago. It has not been my privilege to be here at the meetings for the last few days. I was called out of town and returned today. But I was very anxious that the members of the Institute should have the opportunity to look over the business that it is my privilege to be at the head of and to get at close quarters with some of the ideas and the principles that govern the conduct of that business.

During the few moments that I intend to address you I want to refer to what we have been able to accomplish here and the instruments that have helped us towards that accomplishment, referring to the policy that we have been pursuing, as the result of which I think it is a conservative statement to make — and I hope you will not charge me with egotism in making it — that in this community the greatest return on the dollar invested is obtained at the lowest average cost to the user that is obtained in any large center of population in the world in the manufacture, distribution and sale of electrical energy.

The New Conception of Electricity Supply

The introduction of large prime movers, the large generating units, led us to conceive the idea that the business of electric-lighting-and-power companies is to distribute electricity for all the purposes for which electrical energy can be used in the community. Not merely to manufacture and distribute the energy for use day by day by the retail user of light or the retail user of power, we thought. The field we should occupy was far larger. We considered that the proper function of any public-service company engaged in the manufacture and sale of electrical energy is the operation of all the transporta-

tion systems in the city, the turning of all the wheels of industry, and later, when the time comes for electrification of the terminals of the great steam railroads in the country, to provide them with the necessary energy to operate their business and to a very large extent to distribute it for them.

Our ideas in the direction of the universal generation and distribution of electricity in the community in which we operate are quickened by the enjoyment of the use of nearly perfect prime movers owing to the introduction of the steam turbine. When we started in to dispose of energy to wholesale users we were confined to the unit of 5,000 and 6,000 horse-power. But the steam turbine has made it possible for us to avail ourselves of the large units now in use, running as high as 20,000 and 25,000 horse-power. Before next winter's load comes we shall have operating units up to certainly 30,000 horse-power, and I hope that within a very few years hence sizes will be even larger than that.

We realized that there is a diversity factor just as much in our business of wholesaling energy as there is in our business of retailing energy. The profits of the smallest public-service corporation in this country are obtained from the diversity factor existing between the users of electricity; that is, between one small customer and another. And we conceived the idea of massing the production of electricity for large users and reaping from them a profit for ourselves in supplying them with energy, owing to the diversity factor existing between the large wholesale business and our general business.

It is absolutely impossible for a man to be writing at his desk at the same time that he is going down in an elevator, or be going down in an elevator at the same time that he is returning home in the street car or in the steam car; hence the diversity in demand.

How the Aggregate of Surplus Energy Should be Utilized

In talking to you gentlemen here, members of the American Institute of Electrical Engineers, I want to draw you a picture

of what will come in the future when the time comes for the electrification of all the main arteries of travel throughout this great country, and when the railroad companies draw their energy from the power houses of the existing local companies which are now stretched from the Atlantic to the Pacific and almost from the Arctic Circle to the Gulf of Mexico. Consider all the great hydro-electric stations and steam-electric stations now in operation and building throughout the country. In the aggregate it means enormous amounts of surplus energy at our disposal. That energy will be distributed, whether it is to the small customer who uses one incandescent lamp or to the large railroad system that uses 100,000 or 200,000 horsepower and it will be distributed eventually by practically a single system of distribution. When that millennium comes, as it must come, as it is not only a possibility but an economic necessity,— when that millennium comes we shall be producing and distributing electricity and selling it at the lowest possible cost to the greatest possible number of consumers, the lowest possible cost to the consumer to be whether he be a large consumer or whether he be a small one.

Now take some of the great mistakes, from my point of view, that have been made in the electrification — in what little electrification there has been — in connection with our great steam-railroad properties. Take the experience of two such great institutions at the Pennsylvania Railroad and the New York Central Railroad. A few years ago when we had put into operation, I think, the first large steam-turbine unit in our Fisk Street Station, the New York Central Railroad sent out a most distinguished commission of electrical engineers and mechanical engineers to look into our methods. What was the result? The Pennsylvania Railroad put up its own plant and the New York Central Railroad put up its own plant. If you will investigate the cost of those plants, and the operating cost of those plants, and will charge five per cent depreciation and five per cent for money and then figure out the cost of the electrical energy that they produce, and compare their cost with the contract price paid by the street-railway companies in the

city of Chicago, you will find a difference between the cost to those two steam-railroad companies and the cost if they had purchased their electricity at the price we are in the habit of selling it to any street-railway company wanting it here in Chicago — you will find a difference in cost, after allowing for interest and depreciation, of upwards of $1,000,000 a year.

Railroad Maximum-Demand Period Favorable to Central-Station Operation

Now that is an economic waste; it is an economic waste not only directly to those companies, but indirectly to the electricity-supply companies interested in the community where that electrification of steam terminals has taken place. The advantage of the diversity factor between the two classes of business was lost to both the railroad companies and the electric-service companies. I have lately been trying to find out when the maximum load of the steam railroads centering in Chicago probably occurs, and I mention this to elucidate my point, on the question of diversity; that is, diversity of demand. The only information that I have on which to base my estimates was to take the gross cash revenue of the railroads and its variation from month to month. Based on the gross cash revenue I find that the maximum load of the steam railroads comes in the month of October in this particular neighborhood. I have tried to figure out from the same information with regard to the load on the steam railroads operating between New York and Boston, and based on their receipts I find that their maximum business came in midsummer. I am not familiar with the steam-railroad business, and that seemed somewhat peculiar to me. So I had an interview with Mr. Mellen,[1] of the New Haven road, and he told me the figures were correct. He said that their maximum load came at midsummer. It comes at that time because of the enormous amount of passenger business to the resorts along the Eastern Coast.

1. Mr. Charles S. Mellen, then president of the New York, New Haven and Hartford Railroad Company.

If the maximum load of the steam railroads comes in the months, say, of June or July, it seems to me a very ridiculous proposition to provide the capital necessary to build individual generating plants when at that same time all of the cities between Boston and Philadelphia, including New York, have in the summer a maximum amount of idle generating plants which could just as well be employed in taking care of the maximum load of the steam railroads.

Utilizing the Diversity Factor in Distributing Systems

I will go a step further. If what I have said is true (and we think we have demonstrated its truthfulness so far as the local business of Chicago is concerned, owing to the fact that we have been able to take care of our own business and three-fifths of the local transportation business of this city and raised our load factor from 28 per cent to between 40 and 50 per cent in doing it) as to generating plants, surely it must be equally true in relation to the distributing systems. And in our distributing systems, you engineers know full well, we spend five to six dollars where we spend one dollar in generating plants.

How absurd it would be if, instead of having one vast distributing system here in Chicago for our regular electric-light-and-power business, we conceived the idea of establishing a large number of small distributing systems running out from a central point. What would be the amount of copper used? What would be the amount of capital needed to buy that copper? What would be the financial result on the balance sheet?

Now we today, all of us, pursue exactly that same absurd policy, so far as general distribution of electrical energy is concerned. I think the best case that I can cite is that of New York city, because they happen to have there a few more distributing systems than we have here in Chicago. If you walk down the street in New York you will find one distributing system underground, another distributing system on the surface and another distributing system on the elevated road, and all of them using precisely the same character of electrical

energy — all of them able to save an enormous amount of money if those three distributing systems were put together, in precisely the same way that we tie together the Edison distributing systems in any of our large cities.

By continuing to apply these same ideas to the Chicago situation I am rather hopeful of producing and distributing electrical energy at the lowest possible price that it can be produced and distributed with steam as the prime mover, and as a result to surpass the quantity of production and distribution in that of any other city from one central-station company. The success which we have met with in massing the production of energy can, I believe, so far as economy of operation and capital saving is concerned, be greatly exceeded by massing distribution.

Fortunately for us, I think we have the opportunity of doing that well within our reach owing to the peculiar local conditions that have existed in this community with reference to our transportation properties. I am having prepared a plan for combining all of these primary distributing systems. That is, instead of running out separate cables of large capacity, capable of carrying current of high potential, first out to the Edison substations, then another set out to the elevated-railway substations, and a third set to the surface lines — instead of having three separate systems of that character we plan but one. Further, the plan contemplates but one set of substations. When you distribute from that substation take out just the character of current you may require to use for a certain class of service. That is, instead of having a separate distributing system for 500-volt current on the surface and another system on the elevated structure, to have it all one.

What would be the result of working out such a plan? The first result would be to throw out of use an enormous amount of copper. Or, in other words, an enormous amount of capital. But as we grow with reasonable rapidity in this city our engineers found that the idle investment would all come back into use again in the course of five years. The estimated net result was that after five years a saving of upwards of

$1,250,000 a year would be obtained. This is the equivalent to the creation of $25,000,000, capitalizing the saving at five per cent. That could be done just by having all these things together.

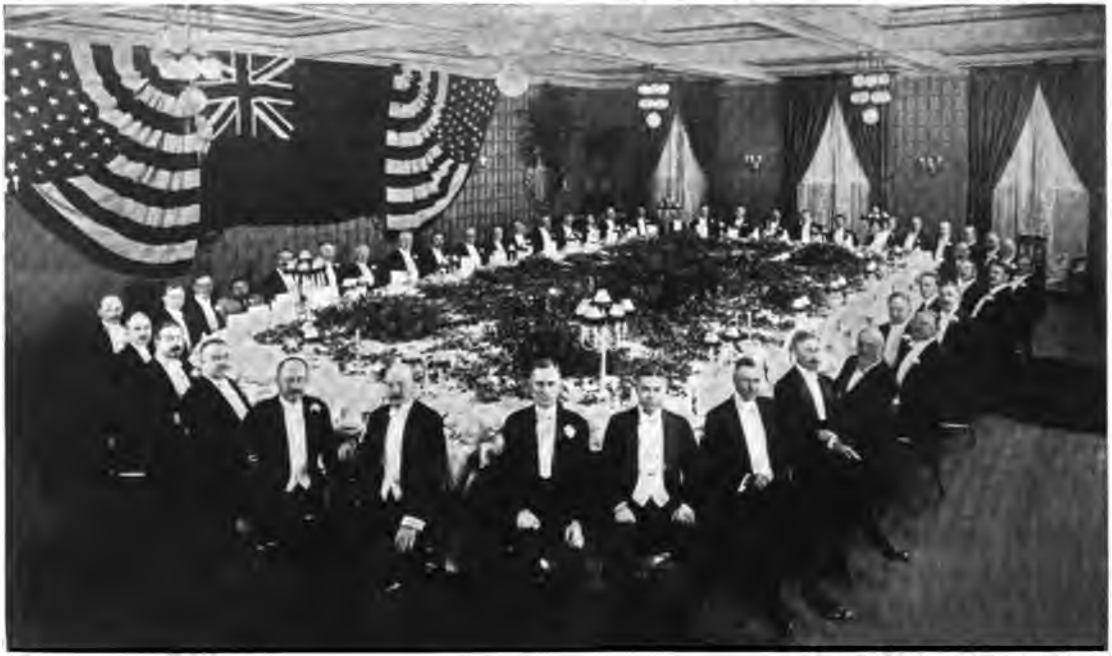
If that is possible in a city like Chicago, what could be done in a city like New York? Our maximum load here at the present time is about 200,000 kilowatts. I suppose, including the generating stations of other companies, it would be not overestimating to say that there is a maximum of 300,000 kilowatts of electrical energy produced in central-station generating plants in this city. I do not know the amount produced in New York. I presume it is nearly three times that, if you take the entire area of the present city of New York. If by putting all these things together, doing what we certainly ought to do if my estimates are correct, we had but one generating and distributing system in New York — if we could create values from savings in Chicago, which, capitalized, amount to $25,000,000 — what would be the value that could be created in New York by following the same methods of engineering?

Massing Production and Distribution — What it Means

I think the most important subject that you gentlemen can engage in is the energy-manufacturing and energy-distributing side of electrical engineering. Following up that subject will lead to a far greater conservation of resources than all the talk we are hearing with reference to shutting down the water-powers and stopping the working of the forests in the western country. This subject points to a saving which, if you will take the whole country, would be represented by figures that are so stupendous that a man would seem to be crazy if he simply guessed at them. I know of nothing that can lead to a greater enlargement of our business than following out the idea of massing production and massing distribution.

It is a common thing for us to read in the daily newspapers of the great trouble experienced in providing money to finance the extensions and improvements in the steam-railroad enter-

prises in this country. Even main trunk lines, with prime credit, find their operations curtailed by the great difficulty of getting the necessary capital. They will be confronted, within a comparatively short time, whether the men in charge know it or not, with compulsory electrification. We offer them a helping hand; we offer to do our part in raising the capital necessary for that electrification and for dealing with that side of the business, namely, the production and distribution of the electrical energy needed — a branch of the business which the steam railroads little understand. However great may be their talent in railroad management, however much they may know as to the conduct of the transportation business, which business is a specialized business just as much as our business is a specialized business, they can afford to come to us for help. If the electrical engineers of this country will take up this subject in a proper way and will come and study what little we have been able to accomplish here locally in Chicago and what it leads to and what it means, they will find it means a future to our business that none of us have ever dreamed of.



Dinner in honor of Messrs. S. Z. de Ferranti, C. H. Merz, and Arthur Wright. The names of those present are given on pages 232 and 233

DINNER IN HONOR OF MESSRS. S. Z. DE FERRANTI, C. H. MERZ, AND ARTHUR WRIGHT, OF LONDON[1]

MR. INSULL: Gentlemen, I deem it a great privilege to have the opportunity of introducing to you — to some of you — and to recall to others of you the acquaintance of my good friends and fellow-countrymen, Mr. S. Z. de Ferranti, Mr. C. H. Merz, Mr. Arthur Wright, and their fellow-visitors, Mr. V. L. Raven, Mr. E. Thompson, and Mr. H. A. Couves.

It is somewhat difficult to get up here and introduce to you Mr. de Ferranti as an Englishman. He is more of an American than I am. His grandmother was born in Poughkeepsie, and came of good old Dutch stock. His ancestry on the other side comes from that part of Europe that is very

1. On September 28, 1911, on the eve of their return voyage, Mr. Insull gave a complimentary dinner at Delmonico's, New York, in honor of several distinguished English electrical engineers who had been visiting electrical points of interest in the United States. A stenographic report of the speeches at that dinner is presented. Reference to the work of several of the guests of the evening is given in the text. It may be added, perhaps, that Mr. de Ferranti is a past-president of the (British) Institution of Electrical Engineers and that his ideas in relation to transforming all the energy obtained from coal into electricity have been set forth at length in a presidential address before that body. Mr. de Ferranti is one of five honorary members of the American Institute of Electrical Engineers, and one of two (Yearbook of 1915) credited to Great Britain. Mr. Charles H. Merz is a consulting engineer of London and Newcastle-upon-Tyne. Jointly with Mr. Frederick Sargent, of Chicago, he designed the addition to the Fisk Street generating station of the Commonwealth Edison Company, of Chicago, put in operation in 1914. One of the generating units in this addition is a 25,000-kilowatt Parsons turbo-generator — the largest imported generating unit in the United States, both the steam turbine and the generator having been built in Newcastle-upon-Tyne, England. The name of Mr. Arthur Wright is perpetuated in the Wright demand system of charging. The speeches made at this dinner and the list of the names of the guests, following the report, are given here with the thought that, with the passage of the years, they may prove of historical interest.

much in evidence this evening in connection with some little disturbances with our old friend the Turk.[1] But it is a very great pleasure for me to introduce him here, when I remember the great work that he has accomplished in connection with the industry with which most of us around this table are connected.

Remarkable Early Engineering Work of Ferranti

While Boston was building its direct-current station at Atlantic Avenue, while Chicago was building its first bipolar-dynamo station on Adams Street, and while the New York Edison Company was engaged in putting in, I think, some of the early marine type of direct-current units, Mr. de Ferranti was designing in London what, from the engineering point of view, is practically our present-day modern system of generation. The machines that he put into the Deptford station, and which ran I think 11,000 or 12,000 volts, of a rating, I believe — the first two of them — of about 1,200 kilowatts, and the conductors that he made to transmit current from Deptford to the West End of London represented practically the same engineering scheme that we have today.

It is a very remarkable thing that he should have foreseen what is the absolute essential of central-station generation and distribution so many years ahead of the time when the energy consumption was of such a quantity as to justify that class of engineering. I have often said at similar gatherings that I consider Mr. Edison's conception of the necessity of the high-resistance filament in multiple and the marvelous description in his early distribution patents stamped him as a great engineer. I do not think the statement is far-fetched if I say that the conception of the necessities of our business worked out by Mr. de Ferranti when he was practically but a boy, only a year or two after he reached manhood, entitles him to very high rank as an engineer in that same class.

So that when we over here are pluming ourselves on our great engineering skill, our wonderful conception of the engineer-

1. Referring to the war between Italy and Turkey then in progress.

ing necessities of our business, we should go back a quarter of a century and see what was accomplished in England at that time to study the first example of what so many of our engineers think was really born in this country.

Value of the Wright Demand System

In addition to the engineering side of our business, we learned another very important thing from that same little isle. Take the work of our friend, Mr. Arthur Wright. I do not think it is any exaggeration to say that Mr. Wright first taught us how to sell electricity. I think that the work which he did in Brighton was the first daylight which we received as to how electrical energy should be sold. I do not care whether it is in the homes of the rich, in cities like New York, where they can pay a high price for electricity and not miss the money, or in a city like Chicago, where we have to depend largely upon the ordinary flat dweller who can only afford to pay $12 or $18 a year. It makes no difference whether we are selling to large consumers, such as we happen to be fortunate enough to have in Chicago, and they would like to have in New York, who buy anywhere from 10,000 to 50,000 kilowatts, or whether it is the product of a hydro-electric plant, from which energy is sold to large distributors. In all cases the fundamental basis of all the contracts made, provided these contracts are made with the idea of making money by them — the fundamental basis on which the current is sold under all these conditions is what is known as the Wright demand system of selling energy. We have to thank our friend, Mr. Arthur Wright, for teaching us the A B C of the selling of electricity.

Some years ago when we in Chicago were struggling with the problem of selling electrical energy to the railway companies, there was a great diversity of opinion in the organization of which it is my privilege to be the head, as to how to do it. Some of my people about that time were going over to the other side — to work hard, as they told me; to have a good time, as I thought — and it happened that they strayed into a commit-

tee room of the House of Lords. The committeemen were considering the question whether the houses of Parliament should grant certain rights relating to the wholesaling of electricity in the metropolitan area of London. Unfortunately for some friends of mine and myself the scheme did not go through Parliament. But the money that the stockholders of the exploiting company subscribed for the purpose of trying to get that bill through Parliament served one very good purpose about 4,000 miles west of where that committee of the House of Lords was meeting.

Mr. Merz as a Pioneer in Selling Electricity at Wholesale

The evidence given before the committee of the House of Lords on the Administrative County of London Bill taught my people that there was money in selling electrical energy at around one cent a kilowatt-hour in the city of Chicago. I have sometimes thought if the directors of the Commonwealth Edison Company had done their duty they would have reimbursed me for the money I lost in that particular enterprise!

The evidence given before that committee was prepared by my friend Mr. Charles H. Merz and his staff, and those companies which are engaged in selling electricity on a large scale in this country to large users owe more to the work of Mr. Merz in that direction than to any other one man, in my judgment.

You can well understand, gentlemen, therefore, what a pleasure it is and what a privilege it is to me to make you all acquainted with these gentlemen and their fellow-travelers, and the pride that I naturally have as an Englishman in feeling, in knowing, that such large contributions in the direction of the commercialization, the real commercial success of the business that we are all engaged in, can be traced to the efforts of some of my fellow-countrymen.

We have advantages here; we have greater possibilities; probably our people have greater purchasing capacity; we

have more rapid development here, and we have far more rapid increase in population. In this country we are able to take advantage, in a way that they are not in England, of the conditions, and we are able to make far more money out of our business than the English operators are able to do; but that should not prevent our recognizing that a great deal of what we do and what we have been able to accomplish we can trace to the study and experiments and efforts of the electrical engineering profession of Great Britain more especially, and also to the professional engineering of Europe.

Gentlemen, before calling upon Mr. de Ferranti to speak, I want to drink to the health of the guest of the evening and his associates, and then we will ask Mr. de Ferranti to talk to us. Here's to Mr. de Ferranti and his associates!

Remarks of Mr. S. Z. de Ferranti

I feel it a very great privilege to be among such a gathering as I see around me this evening and to be able to say a few words to you on a subject that we are all so much interested in. First, however, I must take the opportunity of thanking our host very much indeed for the kind words that he has said about my fellow-engineers, who are over here with me, and about myself. What he has said is part of the overflowing generosity and kindness that we have met with on every side in this country. I have been, of course, immensely impressed with your great engineering work, but this has not impressed me so much as the very kind reception, the very great goodness, we have received at the hands of everybody we have come across. Everyone has tried to do everything possible to make our stay here really enjoyable. In fact, if I might go a little further, I almost would like to say that I feel that "I have come home."

You know how very greatly I am interested in the matter of electrical development, in the larger uses of electricity, in fact in what I shall call the universal application of electricity to almost all purposes. I believe in this because I believe it is a

great means of making savings, of conserving our natural resources. I believe that electricity is the greatest labor saver that has ever been invented. I believe it is only commencing to secure that saving which it will eventually do when it comes into its own.

The saving of our material resources is also another very great matter. We are throwing away and wasting untold wealth at the present time, because we have not yet got to the point of understanding our work sufficiently, or seeing far enough into the future, to see that we can do any better than we do today. On those lines electricity will develop and progress to an enormous extent; but it is not on those lines that electricity came to be used and that electrical engineering work was started upon.

The first real commercial application of electricity, I suppose, was the electric telegraph. That was not really to take the place of anything. It was not to displace the small engine in the works by means of an electric motor which did its work better. It was to fill an entirely new field, to give us means of communication which had not been dreamt of before. That was perhaps the first great application of electricity.

We then had a large industry in electroplating, which I think in order came along next. That, although it gave us entirely new articles, and an entirely new trade, to a certain extent took the place of an existing commodity; namely, what was known originally as Sheffield plate, and which is now an almost forgotten thing.

Then we come along, I suppose, to the first applications of the electric light, which was almost something in the nature of a scientific wonder. It gave a lot of brilliancy that had never been known before. It was naturally expensive and difficult to produce with batteries, but quite a new thing in development. Then came the idea of electric light from central-station supply. Of course, you know the various stages things have gone through in electrical matters, and you will see that they have been characterized partly by supplying an altogether new field that was not touched before, and partly by replacing some

existing system, some existing style of filling our wants which was already in operation.

Take two cases of that. We have only to think of the telephone and its immense development. That was entirely a new thing. In a sense it did away with telegraphing a bit, but really that is a small part of its utility. It was an entirely new field that was filled by the telephone. On the other hand, take the case of the electric light as you know it today. As it was introduced many years ago, in incandescent lighting, when it came in it competed with oil lamps and gas supply.

Well, that is how electricity has gone on from stage to stage, until we have got to the present time.

Using Coal by the Electric Route

It does not require much persuasion to realize the immense expense of the electrical industry, the size of the business, the immense amount of money invested in a great sphere of usefulness, in the number of your wants that are supplied by it; but, notwithstanding all that, it is only a very small thing, when you consider what the possibilities of electricity are. Really, if you carry it to its ultimate end, when it is sufficiently far developed, you will see every bit of coal that we now use for power, light and heat, and electro-chemical work — you will see, surely, when our knowledge is sufficiently advanced, all these things must be done by the medium of electricity. That is to say, where it is a question of coal, we will burn our coal into electricity, and by that round-about process do more economically all the different things we are doing in a more direct way today by coal.

I went into the figures, so far as they relate to England, and so far as I could see there was not one per cent of the coal which was being raised from the mines that was being turned into electricity in England. Suppose, say, you are twice as well off in the way of electrical work. I do not think that is so, but in relation to the coal consumption in this country, suppose you are twice as well off, and that two per cent of the coal mined

in this country today is being turned into electricity for the general uses to which electricity is put. Just think of that in relation to the 98 per cent which ought to be turned into electricity, and which will be turned into electricity, when you gentlemen have evolved the means of doing it.

I do not think that is in any sense a fantastic idea. I say it in all seriousness, and before such a meeting as this, that I thoroughly believe — I am quite convinced — that the time will come when for all purposes it will pay to use coal by the electric route.

I will not enlarge on what it will mean. You gentlemen represent very great and important undertakings. I do not know what the size of your industry will be when my ideas are realized, but it will be something very big. Now, just see for a moment what it would mean if we could do all our work electrically, and let us see what are the conditions that would have to be created to bring that about. In the first place, to make such a thing possible you must be able to turn a much larger percentage of the heat energy of the coal into electrical energy. I think that goes without saying. I do not imagine that we have got to go such a very long stretch forward before we will get such a return of the heat energy of the coal in the form of electricity as will warrant our using the coal by electric means for practically all purposes.

That is the first thing. The second, of course, is one which can come only with time and practice. That is, the perfecting and cheapening of all the means of transmission and transformation. By transformation I mean the transformation of the electrical energy into the final result, whether it is heating, whether it is steel, or some chemical product, or whatever it is that coal is used for today. These things have got to be improved, and the capital costs have got to be much reduced, possibly by direct improvements of all the apparatus used and partly by the much greater scale of operation. Surely, when that state of affairs comes about, when you get across the critical point in the amount of electricity you can get from your coal, and when you can carry out the applications with certainty,

and success, and sufficiently reasonable price, then I feel sure that this general electrification will gradually become the order of the day.

Great Savings to be Effected

What are the results that we can hope to follow from such state of affairs? I am not ashamed to speak of them, too, this evening, because, as I say, I do not think that these things are visions of the future only. I think they are very much nearer than we can readily imagine. To begin with, I am sure such a state of affairs would save a large amount of the coal we now use. Of course, there is always an increase going on, and we always want more coal; but taking it at any one time, I believe one might reasonably hope for a saving of probably half the coal which we now use. There is the first great point in the conserving of the natural resources of any of the civilized countries. Secondly, you get back to a thing which follows from the better use of the coal.

Part of such a process as I have sketched out to you would mean burning the coal in such a way, or using it in such a way, that you would not throw away the valuable by-products that are contained in it, and which we know today quite well we can get at, and which we do get at, but which it does not generally pay us to extract or utilize. The great thing, as you know, in the coal is the fixed nitrogen, of which we get a comparatively small percentage today. If we were to get anything like a reasonable return in using the coal of the fixed nitrogen in the coal, we should then have the means in any country such as this — in other countries, no doubt, but especially in such a country as this—of maintaining our lands fertile notwithstanding the continual use of those lands, and without any diminution in their value as producers of agricultural products.

At present there is a great depletion of the land; its value is being sapped — I do not say by unscientific work, but owing to the fact of lands being plenty and there being plenty more within reach, so that our food supplies can be brought from this newer land, and so the old land is being neglected, the

older part of the country is becoming less fertile, and this is going on while we are throwing away our means, ample means, of keeping it as fertile and as good as the first day it was used. That follows as a part of the process which it would be necessary to bring about for a universal use of electricity.

The last point is the immense labor-saving character of electricity. If you are required to mine about half the coal, there would be a very large saving in labor, which could be turned to another account. There are great difficulties, of course, in transferring labor from one industry to another, and there is much difficulty in getting men to adapt themselves to new situations, but still everything saved is so much to the good, on the basis of enriching the country and making it more prosperous, and that must, in its turn, react on the whole population of the country.

The first great saving would be in the reduction of the mining work necessary to accomplish our results. The next thing is in burning the coal, in transmitting the coal into energy. I am not speaking so much of hauling it long distances to the centers of population, or in distributing it, or getting it to the consumer, but I refer to the actual burning of the coal in furnaces. In this operation you get the damage done to these furnaces; there is the trouble of clearing up the mess generally that is produced there and in the cities by the burning of coal. All that represents a large amount of labor. We all know it; it is perfectly apparent to us, and we are doing all we can to prevent it — we are electrifying more and more — but just think what the conditions would be when the scheme I have outlined is all complete. Of course, you know of what great savings have been made in the application of electricity up to this time, in the way of motive power and all the other things which it has been applied to. There, again, you will come in for further labor saving.

A Great Result to Look Forward To

I must apologize, almost, for talking to such an audience on such a subject, because I have not been able to tell you any-

thing new; I have not been able to tell you anything that you did not know before; but I have ventured to take your time to remind you of some existing things, and the things which may be developed in the future, and to point out to you the direction in which I hope you will work to bring about the results indicated. Personally, I am not ashamed to present these things to you, and I feel perfectly confident of what I say. The thing I cannot tell you is the time when these things will be realized. If I could do it, it would be very useful. I cannot say quite when this result will come about, but it will come about, and will come about as a result of such work as you gentlemen here this evening are doing in developing the electrical industry from the point of manufacturing machinery, perfecting apparatus, bringing electricity to the door of the consumer, and instructing him how to use it most economically. It will come by the work of all of you, not by any one invention but by the result of general progress, the progress which must take place when a number of earnest and skilful men concentrate their endeavors in bringing about a result.

It is a thing I like to look forward to with joy and pleasure. Electricity has been my life work and hobby, my greatest delight, and I have no doubt your work in electrical matters has taken the same form with most of you. Gentlemen, I hope the result I speak to you about will be brought about by your efforts within a reasonable time.

Mr. Insull: Gentlemen, the picture Mr. de Ferranti has drawn of the possibilities of the generating stations and distribution systems of this country is somewhat at fault from one point of view, and that is he has not indicated to us how we are to provide the necessary capital for such developments. I suppose it is within reason to say that our business — that is, entirely new developments; I do not mean re-financing, but extensions to our plants to enable us to take care of business offered — requires somewhere between $100,000,000 and $150,000,000 a year, according to the conditions of the business. If any such development takes place within our

time as Mr. de Ferranti speaks of, it is almost impossible to think of the amount of money that will be needed to take care of the business that would be offered to us. Under these circumstances, it is very natural for us to look for a banker, and I have great pleasure in calling upon my friend Mr. Frank A. Vanderlip, president of the National City Bank of New York City, to give us some light on how we can do it.

Remarks of Mr. Frank A. Vanderlip

I felt a good deal out of place in this company of technical experts when I first came in, but as the guest of the evening and I were "reminiscing," I found that in the same year, when we were both boys, just the same age, we each built a dynamo; we each had great ambitions to go into the electrical field. We each built a small dynamo and we ran one arc light each. Now, our guest went on, but I was not able to do so, in that field; but recalling these early ambitions has certainly given me a great fellow feeling for the work you are all doing here, and for the great work that he has done.

During the conversation that I have had with Mr. de Ferranti I have been greatly interested in the story he has told me of the handicap that electrical development has labored under in England — the handicap of the public attitude towards the municipal ownership of the plants there. He has labored in a field that is nothing like the field that you have enjoyed, because of that attitude of the public.

Now, if he has been observing something of the political and business conditions here, as he has the technical conditions, he has found us in the midst of a most distressing situation — a situation wherein the very foundations of our industrial conditions are disturbed, because of the public attitude toward industries, because of the public attitude toward monopolies, and of this public desire to cure evils, which the public believe exists, by force of competition.

I think the field of electrical development, perhaps, is rather happily situated in regard to the very disturbing con-

ditions that other fields of industry are now laboring under. We all pretty well recognize the necessity for monopoly in the electric-light industry. It is a recognition of that feature that has enabled us to make very considerable strides in making popular in a financial way investments in electrical enterprises. For a good while, after the first great expenditures of capital were made, capitalists looked with a good deal of disfavor upon investments of this character. They do still. I am told that in England they look upon them with decided disfavor.

We are only beginning in a few cases to create electrical securities so that they really command the respect of most conservative investors. That was necessarily so in the way that we have developed. There are several thousand individual electrical companies operating in this country, I think, and they have raised a great sum of money. But when they began to unite themselves they presented a broader field of investment, so that the investor does not feel that it is necessary for him to have technical knowledge in regard to the conduct of the particular business, and this really greatly broadened the field for conservative investment in electrical properties.

Investors Require Stability

Mr. de Ferranti has said that present methods of utilizing the energy latent in the coal are to be very much improved. That sort of thing rather frightens the capitalist, after he has seen the scrapping of electric machines in a very few years, after they have been in service but a short time. He has seen the danger of competition coming in with newer forms of machinery, endangering old investments, and this work which you are all doing to get nearer to the point of efficiency, while it is absolutely necessary, must be vitalized by the confidence of capital. There must be a feeling on the part of the investor that there is a certain stability in the investment.

That stability stands not only on the technical excellence of the work which you do, but it stands, too, on the attitude of the public towards your big institutions. We have a ten-

dency now toward public-service commissions, toward a greater control, and on the whole I believe that development is on the side of stability, if it does not go too far. It has, in some ways, gone too far in most of the prominent instances where it is exercised, but it has also brought great advantages, the advantages of recognized monopoly. It is no longer so easy to have "strike corporations" come into the field and endanger old investments.

You have before you a work that is just as important as any technical work which you are doing — the work of satisfying the public that you are being fair, that you are giving the public a square deal and the sort of a square deal that the public demands. I believe if you will give that square deal, that you are going to get, on the whole, fair treatment. You will not always get it, because the interests of the public are in the hands of men frequently not well trained, not with a full knowledge of what is fair. But I believe you have got as important work on that side as you have on the technical side, in giving fair treatment to the public, so as to insure fair treatment in return, and unless capital feels certain of that fair treatment, the day which our guest looks forward to is going to be long deferred, because of the lack of the vitalizing influence of this great amount of capital which may be slow in presenting itself unless the conditions are attractive.

Mr. Insull: There is such an accumulation of talent, electrical talent, scientific talent, that we have around this table, that it is rather a dangerous thing to call upon any particular guest as a scientist; but there is one man for whom we all have great admiration, and many of us have great affection, and that is my friend Dr. Charles P. Steinmetz.

Remarks of Dr. Charles P. Steinmetz

Electrical engineers of the English-speaking nations on both sides of the Atlantic: I have been delighted to meet Mr. de Ferranti, personally, the first time on this occasion, although

I knew him by reputation as long as I have been an electrical engineer; in fact, a good deal longer because, while I was studying the rudiments of electrical engineering, I was reading of the great work he had done in England. I was very much surprised to find him relatively such a young man — one whom I always regarded as one of the early pioneers who had in those bygone ages done the work we are just beginning to do now; that is, to build the electrical generator of thousands of horse-power, and to transmit electrical energy up to 10,000 volts in underground cables. I recall in those days that I read in prominent electrical papers of instruments that would measure as much electric current as is used to run an arc lamp.

Well, gentlemen, in the days which have elapsed since the twenty or more years ago when this early work was done by our friend Mr. de Ferranti, we have carried the work in this country much farther. We are not measuring our stations any more by thousands of kilowatts; we measure them by hundreds of megohms. We are running underground cables for distances of hundred of miles, with voltages higher than 10,000 volts, although I do not question that some of my friends around the table here who have high-voltage underground cables wish that their cable record was the same as that of the old Ferranti cable of more than twenty years ago, which is carrying 10,000 volts today.

Value of de Ferranti's Early Work

But if we have carried the work farther we have done what all good pupils do when they leave their teacher's school; they apply what they have learned. When they have a chance, as in a new undeveloped country, with great opportunities, they may apply it on a larger scale than their teachers have done, but they stand on the work of their teachers, of the pioneers who have done the work, and to a very much larger extent than most of us realize now.

There, in the old station, de Ferranti transmitted alternating current at 10,000 volts with underground cables to do the work

of the city of London at that time. There, too, many phenomena were studied and recognized and controlled which have become familiar to a few of us only during the last few years, and remind us of the Ferranti effect — the rise of voltage along the cable, from the generator onward, by the leading current, the charging current of the cable. I remind you of the phenomenon which we have gradually learned to control, which is that the breaking down of the insulation is not the result of the voltage of the static field only, but of the searing effect at the edge of the static field. Now we bevel the rim of the cable. That is an old effect, observed long ago. I remind you that, where we protect our system by aluminum arresters, by the most powerful protective devices, it was de Ferranti in bygone ages who discovered and developed this method of protection. So most of the prominent work which we now utilize to protect our systems dates back to our teacher's work during those days when we knew very little about electrical engineering.

We have done these things on a larger scale than was feasible or dreamed of in those early days; but after all we must recognize that the work of the world today is not yet done by electric power; it is done by steam power, and only a very small proportion of the wheels of industry are run by electrical energy. There is a vast field which we still have to conquer and which we shall conquer. It is true, at present, when we use coal to produce electric power we get only a small percentage of the energy of coal back as electrical energy, one-tenth, or perhaps one-fifth of it. We may some time in the future improve that; but if only one-tenth or one-fifth of the energy of coal is given to us as electrical energy, then, gentlemen, reversing that process, we should get from electrical energy five or more times as much energy as heat, for everything is reversible.

In producing light we use electrical energy very largely. We find it is more efficient than the direct use of the chemical energy of combustion, because we can control it better; we can escape the losses by diffusing the light-giving material in the vacuum of an incandescent lamp; and to produce electrical

energy for producing heat we are not limited by being obliged to provide a supply of air to carry away a large part of the heat as in the case of combustion. There we can use the same remedy, and can also reduce the loss to a small fraction of what is inherent in the coal burned, by limiting the access of air, by bringing up the vacuum and by other means. You see by our present relatively low efficiency of production of electrical energy from the energy of coal, we could produce, economically, heat from it, and will do it much sooner than we think.

Will Electrical Energy Run the World?

So there is a vast field for electrical energy — broader fields which we are not considering to a large extent. Some time in the future our coal mines will be exhausted. Then electrical energy will be the only thing which can keep the wheels of industry running, or transmit the power of the waterfall, of the rivers, the tides. Some time in the future, the fertility of our lands will be exhausted. Land has already ceased to be fertile in many parts of the country, like our eastern states. To some extent then we shall have to rely on electrical energy to restore the fertility, to produce fertility. It is being done now, commercially, under very favorable conditions.

With the advance of engineering, many of the things which are not thought of at the present time as being within the field of the application of electricity will come into view. But then, all these developments which are in the future, we hope in the near future, have, as Mr. Vanderlip explained to you, to depend on the financial side also. In that direction we can look to our pioneers, men like Mr. Wright, who have shown us that it is not merely the strictly technical side of distribution of electric power which must be considered, but that there is another side, the side of selling. It is Mr. Wright, our guest, who is the originator of the theory of the cost of electric power, who has shown us its relation to load factor, diversity factor, and demand. We now apply Mr. Wright's system, as Mr. Insull has shown and told us, with extreme success. And in this

manner, you see, we are advancing because of the benefits which we have derived from the work of the pioneers, our guests here tonight, who honor us by their presence. We have profited by the labors of these gentlemen, and I hope we will all see the accomplishment of the prediction of Mr. de Ferranti, where you really will be able to see electrical energy running the world.

MR. INSULL: It was not my intention, in inviting you here this evening, to have any considerable number of speeches. We have reached the end of our speech-making, but before dispersing, I am sure you all join with me in wishing our guests a safe return home and in expressing the hope that we shall have the pleasure of seeing them again in this country at a very early date.[1]

1. There were forty-six guests at this dinner. Following is a list of the names of the gentlemen present, alphabetically arranged, the occupational titles given being as of 1911:

Anson W. Burchard, Schenectady, N. Y., assistant to president General Electric Company.
H. A. Couves, Newcastle-upon-Tyne, England, engineer Newcastle-upon-Tyne Electric Supply Company.
Francis B. Crocker, Crocker-Wheeler Company, Ampere, N. J.
Charles G. Curtis, New York, N. Y., engineer, inventor of Curtis turbine.
Henry L. Doherty, New York, N. Y., president Henry L. Doherty and Company.
Alex Dow, Detroit, Mich., first vice-president and general manager Detroit Edison Company.
Charles L. Edgar, Boston, Mass., president Edison Electric Illuminating Company of Boston.
William C. L. Eglin, Philadelphia, Pa., electrical engineer Philadelphia Electric Company.
William L. R. Emmet, Schenectady, N. Y., engineer General Electric Company.
Louis A. Ferguson, Chicago, Ill., second vice-president Commonwealth Edison Company.
S. Z. de Ferranti, Grindleford, Sheffield, England.
Weldon W. Freeman, Brooklyn, N. Y., second vice-president and general manager Edison Electric Illuminating Company of Brooklyn.
John F. Gilchrist, Chicago, Ill., assistant to the president Commonwealth Edison Company.
John H. Gulick, Chicago, Ill., auditor Commonwealth Edison Company.
John W. Howell, Harrison, N. J., engineer General Electric Company.
Charles R. Huntley, Buffalo, N. Y., president and general manager Buffalo General Electric Company.
Samuel Insull, Chicago, Ill., president Commonwealth Edison Company.
George J. Jackson, New York, N. Y., vice-president National Conduit and Cable Company.
Professor Dugald C. Jackson, Boston, Mass., Massachusetts Institute of Technology.

John W. Lieb, Jr., New York, N. Y., associate general manager New York Edison Company.

Herbert Lloyd, Philadelphia, Pa., president Electric Storage Battery Company.

Jesse R. Lovejoy, Schenectady, N. Y., vice-president General Electric Company.

Robert Mather, New York, N. Y., chairman board of directors Westinghouse Electric and Manufacturing Company.

Joseph B. McCall, Philadelphia, Pa., president Philadelphia Electric Company.

James H. McGraw, New York, N. Y., president McGraw Publishing Company.

James R. McKee, New York, N. Y., chairman sales committee General Electric Company.

Samuel McRoberts, New York, N. Y., vice-president National City Bank.

Charles H. Merz, London, England, consulting engineer.

Sidney Z. Mitchell, New York, N. Y., president Electric Bond and Share Company.

Thomas E. Murray, New York, N. Y., general manager New York Edison Company.

Loyall A. Osborne, Pittsburgh, Pa., vice-president Westinghouse Electric and Manufacturing Company.

Charles W. Price, New York, N. Y., president Electrical Review Publishing Company.

Professor M. I. Pupin, New York, N. Y., Columbia University.

J. R. Raven, mechanical engineer Northeastern Railway of England.

E. Wilbur Rice, Jr., Schenectady, N. Y., vice-president General Electric Company.

Edward P. Russell, Chicago, Ill., Messrs. Russell, Brewster and Company (bankers).

Frederick Sargent, Chicago, Ill., consulting engineer (Messrs. Sargent and Lundy).

Professor Charles F. Scott, New Haven, Conn., Yale University.

Henry G. Stott, New York, N. Y., superintendent motive power Interborough Rapid Transit Company.

Frank J. Sprague, New York, N. Y., consulting engineer.

Charles P. Steinmetz, Schenectady, N. Y., consulting engineer General Electric Company.

R. Thompson, assistant mechanical engineer Northeastern Railway of England.

Frank A. Vanderlip, New York, N. Y., president National City Bank.

Herbert A. Wagner, Baltimore, Md., vice-president Consolidated Gas, Electric Light and Power Company.

Schuyler S. Wheeler, Ampere, N. J., president Crocker-Wheeler Company.

Arthur Williams, New York, N. Y., general inspector New York Edison Company.

Arthur Wright, London, England, consulting engineer.

OPPORTUNITY FOR ADVANCEMENT[1]

ON THE last occasion, about a year ago, when I had the pleasure of addressing you,[2] I told you that I hopéd that during the year now closing you would be able to double your membership. You have had the good fortune to go away beyond that, so that now you have about 60 per cent of the possible eligibles in membership in this association.

I think that this body is becoming symbolic of our company organization. Naturally our board of directors looks to the executive officers for the general management and direction of affairs; but it would be impossible for those officers to attain the success that has rewarded the efforts of the Commonwealth Edison Company if it were not for the loyal assistance of the various committees in the organization and the concentration of intellect that these committees bring to bear on the various problems which naturally arise in an enterprise as large as ours and in an industry as young.

After all, this body is but a continuation of that same idea. The opportunities that the members of the Commonwealth Edison Company Section have of acquiring information must necessarily aid them in their duties to the company for which we all work, and in a larger sense the opportunties to exchange ideas at the annual convention of the National Electric Light Association must follow all the way down the line, and assist every member company of that organization and every member of every company section of that organization.

I shall not be satisfied myself with this Commonwealth Edison Company Section until the day comes when every man

1. Speech at the annual meeting and dinner of the Commonwealth Edison Company Section of the National Electric Light Association on November 1, 1911.

2. See "Employees Urged to Study Economic Questions," page 161.

in the company's organization who is eligible for membership actually joins the section. In fact, I think the day may come when membership will be viewed by the officers of the company as the first evidence of a man's desire to improve himself, and consequently improve his usefulness to the company, and as a result improve his usefulness to himself, or, in other words, improve his earning power for his own benefit.

On previous occasions I have referred to the benefits coming to members of this section. If you take the Proceedings of the National Electric Light Association's convention alone, they form today from year to year practically the textbooks of our business, as they deal with every branch of the industry, whether it be commercial or technical. They afford to every young man who aspires to prominence and to position in the great industry in which we are all engaged the opportunity, in connection with his experience from day to day in his own work, to get the necessary knowledge to fit him for the higher positions, which, instead of decreasing in number, are greatly increasing in number, as the importance of our business increases, and as our operations grow on a greater scale every year.

From Office Boy to Vice-President

It always affords me very great pleasure to address my own people. I like to feel that I am one of them. As the years have rolled by and as the business has grown greater and larger, it is impossible for me to have that close, personal familiarity with all the people around me that I used to have in the early days of the development of the business. But it is a very great pleasure to me, as I approach the close of twenty years of service in the Edison company, to look around and see some of the older men growing gray and older with myself. I hope and I know that they have no less enthusiasm than they had when it was my privilege first to take charge of this great business.

I can look back still further here and see around me friends and co-workers of almost thirty years ago. It is a very great

pleasure to see them, and to see that as I have been fortunate enough to advance in this business that we have engaged in, so they also have been able to advance.

You may say that, in speaking on the subject of personal opportunity and advancement, I am talking on possibly a hackneyed subject, but I mention it because I want to emphasize my experience and the experience of those who have grown relatively old (we all started young and we still like to feel that we are young in a way). I mention it for the encouragement, as I have said to you before, of the younger men around me. There are just as great opportunities in this business today as were offered to the young man starting as an office boy in the old Adams Street building years ago and who this year has been placed in the highest position of honor that is in the gift of this great industry; namely, president of the National Electric Light Association.[1] There is no reason whatever why many of you in this room, relatively young, relatively occupying minor and obscure positions in the company's service, with really far greater opportunity for success than that afforded to Mr. Gilchrist — there is no reason why you should not succeed as he has succeeded, and reach the goal which he has reached.

Great Opportunities Offered

There are a few things necessary beyond ordinary intelligence and fidelity to the service you are engaged in. They are ambition, "sticktoitiveness," plenty of hard work and taking hard knocks. Do not look at those hard knocks from the position of the under dog, but look at them from the same viewpoint that the schoolboy looks at them, that the junior in college looks at them; that they are part of the training to make you resourceful, self-reliant men. If you do that, if you take advantage of the great opportunities afforded by an or-

1. Referring to Mr. John F. Gilchrist, vice-president of the Commonwealth Edison Company (1915), and in 1911 president of the National Electric Light Association.

A View in the Grounds of the Northwest Generating Station of the Commonwealth Edison Company, Chicago

ganization like this, your prospects are just as bright and the possibilities of success twenty years hence are just as great as the success being met with today by the principal officers in our company organization. As I have said, they had far less opportunity, far less chance of the emoluments that success brings, than is opened to those like yourselves engaged in an industry into which the capital of the country flows so much easier today than it did twenty years ago, or fifteen years ago, or ten years ago.

There is another point that I would like to refer to, and that is the great influence of the National Electric Light Association in the direction of the personal welfare of its members, and the personal welfare of the employees of its member companies. I refer to the great work that has been done in the last two or three years by the public policy committee of the National Electric Light Association, working on such subjects as savings funds, pensions and the like.

These are all subjects that you are vitally interested in, and the amount of time given by some of the great financial leaders in the electrical industry in connection with the work of the public policy committee was referred to quite at length in the last convention in New York. The conferences that have taken place on the subject of the welfare of the men in the service in the last few years have led a number of the member companies, including the Commonwealth Edison Company, to take up such subjects as, for instance, the savings fund.

At the present time, if my memory serves me correctly, you people in this room — as I suppose that the Employees' Savings Fund members are composed largely of the men in this room — have invested in the company's securities upwards of $110,000, and that investment is going on at the rate of upwards of $5,000 a month, so that probably by the time the first five-year term is up, when the time comes for the first division of money or securities, as each depositor may elect, the chances are that we shall probably have upwards of half a million of dollars of our employees' money invested in our business.

Employees Urged to Invest in the Business

Now, there are only 70 per cent of the men who are eligible for that employees' fund who save money from month to month by depositing with the fund. The chances are that if we had all of those who are eligible, the amount at the end of five years would probably exceed $750,000.

I want to urge you, next to your duty to yourselves in equipping yourselves for the higher positions in the business, to provide for a rainy day, to use your influence among your fellow-workers, so that they will provide for a rainy day. In urging you to do this, I am urging you to take a course that is peculiarly beneficial to yourselves, and one, if you consider it carefully, that you will realize is not only a benefit to you but a benefit to those who are dependent on you, who are family connections of yours, as nothing can so help a man to take a proper view of affairs in times of trouble as to feel that he is supported by a respectable bank account. I know of no better way for you to save your money than to invest it in the business in which you are engaged. If that business has the stability to justify you to spend your time in its service, surely that business should recommend itself to you as one in which you should invest your money.

I am particularly anxious to see the largest possible ownership in the company for which we work held by our people who contribute toward the results achieved by the enterprise; and it is for that reason that I refer almost on every occasion when I have the privilege of addressing you to the subject of the savings fund.

The board of directors of the Commonwealth Edison Company is now engaged in another effort somewhat in the same direction but of a more permanent character, and possibly of more permanent value to the employees of the company; namely, a pension fund. We hope to get in operation at an early date a scheme that will reward steady, constant attention to work in performance of service, and enable a man, in addition to his own efforts in the direction of saving, to look

forward to having a competence in old age as the result of the service that he has rendered to the corporation.

Now, we are very much given to looking back over the last ten or fifteen or twenty years, to "reminisce" on the wonderful progress that the electric-light-and-power industry has made. But to my mind, when I speak of the opportunities of the future, I think that the progress so far made is but a very small part of the development that must ultimately take place in all the great industrial centers and the territory surrounding those centers.

We have tried to do something in that direction here in the city of Chicago. It has been the privilege of the Commonwealth Edison Company to have a great opportunity to show what could be done in the way of massing production and distribution of electrical energy, and reducing its cost as a result, giving cheap electricity to the smallest customer and the largest corporation.

I firmly believe that what we have achieved so far in that direction is but a start in the ultimate results that will be achieved either by us, or by somebody who follows us, in the production and distribution of energy for all kinds of purposes, domestic, commercial, industrial and transportation. And as to the last, that transportation may be urban, interburban, or even interstate.

The lessons that we draw from the work that we have so far done show most clearly that the production and distribution of energy in this great country will be concentrated. Certainly where density of population has reached at all a high point, say, from the Atlantic seaboard to the Mississippi, the work that we have done in the direction of massing production shows most clearly that the wheels of industry, whether they be on the permanent way of a trunk-line railroad, or in some great hotel building like the one we are in,[1] will be turned by the production of energy at a relatively few central points.

To me, the outlook is as bright as it has ever been. The possibilities are greater than they have ever been, and to you

1. Hotel Sherman, Chicago.

whose average years may be half my age will be given the opportunity to see the possibilities brought to actualities.

I simply appeal to you to do your part so that you will be fitted to occupy positions that are prominent, and get the reward that comes to constant and intelligent service.

CAREERS OF TWO ELECTRICAL MEN[1]

THERE is a great deal to be gotten out of our business beyond the mere humdrum of work. There is nothing to my mind more elevating, whether it be to the old journeyman in the business or to the young apprentice, than to meet together, to listen to the experiences of those who have had, perhaps, better opportunities, or who on account of their age have managed to achieve greater distinction in the business, and to get from the remarks and the presence of men like Mr. Byllesby the inspiration that should lead all of us to greater successes in the business in which we are engaged.

It is rather a remarkable thing that we have here in Chicago two men, one especially prominent in the engineering side of our business, and the other especially prominent in the financial side of the electrical business. Both of them started on their business careers at about the same time — one of them after he had left one of the universities of Pennsylvania (I believe Lehigh University, although I am not sure), and the other after a beginning in the "old country." I refer to Mr. Byllesby and Mr. Sargent. Mr. Byllesby was a draftsman at the Wetherell-Corliss Engine Works in Chester, Pennsylvania. He left those works to enter the service of the Edison Electric Light Company of New York in the spring of 1881, where I first met him.

Mr. Frederick Sargent took the position at the Wetherell Engine Works vacated by Mr. Byllesby; and when Mr. Byllesby left the service of the Edison Electric Light Company to go

1. Mr. Henry M. Byllesby addressed the Commonwealth Edison Company Section of the National Electric Light Association on December 5, 1911, his subject being "Public Utilities and Progress." Mr. Insull introduced him to the audience, the greater part of the prefatory speech being reproduced here. This extract puts the author in a new light, that of a biographer-in-brief.

further afield in the electrical industry, Mr. Sargent left the Wetherell works and took the position vacated by Mr. Byllesby in New York. Now as they have reached the middle course in life, becoming better known in their business and achieving greater distinction, one, Mr. Sargent, is at the head of his profession, the electrical engineering profession, in this community, and the designer of our wonderfully economical central power stations, and the other, Mr. Byllesby, is one of the leaders in the Central West in the financing of electrical industries.

I mention the cases of these two gentlemen as examples to the members of the section, of what can be done. They started equipped, one with the ordinary collegiate education that a graduate gets in this country at our universities; the other with the shop experience gained in one of the great works around Glasgow in Scotland. Without any influence, without anything back of them except their own ability and perseverance they have achieved distinction in the two branches of the same business which they adopted. I think what they have accomplished should be an inspiration to all of you, and with that thought to leave with you, I will conclude and introduce to you my friend Mr. H. M. Byllesby.

A CERTAIN HOSTILITY TO PUBLIC-SERVICE CORPORATIONS[1]

WHEN you asked me to speak on the subject of "Public-Service Corporations," I naturally assumed that you referred to local public-service corporations, and I felt some hesitancy in talking upon the subject, because in a way I am touting my own wares. But the public service, whether it be in the hands of private capital or whether in the hands of the municipality, is, after all, one of the most important subjects that we can discuss.

In this city practically all the public services, all the utilities with the exception of water supply and sewage disposal, are in the hands of private capital. We are fortunate enough to be in the position where we probably have less "water" in that capital than in any large metropolitan city that I know of on either side of the Atlantic.

There is about $450,000,000 to $475,000,000 invested in public services (outside of the services run by the city) in this community. The gross revenue paid by the citizens is somewhere between $75,000,000 and $80,000,000. If you count a man at his office and a man at his home as two individuals the chances are that the public services of communication, of illumination and energy deal with at least 750,000 customers. And if you include the transportation on surface and elevated lines, they deal with 1,000,000,000 additional customers a year.

The public services pay to the city and county and state, either in the form of taxes or in the form of compensation, an amount equal to 12.5 per cent of the entire expenses of the municipality, the county, the parks and the Sanitary District.

Thus the institution of public service in this community is

1. Speech before the Commercial Club of Chicago on December 9, 1911.

of vital importance to every citizen. The utilities are owned to the extent of somewhere between 60 and 70 per cent by the people of this community or the people of this commonwealth. Whenever a blow is struck at these properties it is struck at the people themselves, because if they are not the owners of the property, they are the customers of the property; and any blow that is struck must lead to increased expense of operation, and in the final analysis the customer is the man who has to pay the bill, as capital invariably gets it wage, just as labor invariably gets its wage.

Now, what is the attitude of the community toward the public service? I think that is best illustrated by the attitude of our press. I have only to refer to the great change that has taken place in the attitude of the press with relation to industrial combinations since the decision of the Supreme Court[1] showed the people of this country that there were two sides to the subject of industrial combination.

Immediately after the decision of the Supreme Court many individuals began to talk of the necessity of constructive legislation. Following that the serious newspapers of the country began to talk of the necessity of constructive legislation. One of the principal speakers on that subject in this community, Mr. Baker,[2] has referred to the necessity of constructive legislation tonight.

"Friendly Hostility"

If you will take the attitude of the press toward our local public-service corporations, you will find that it is one — if I may use the term — of friendly hostility; and I think that this reflects the feeling of the community.

I will give you one or two personal instances. I remember some years ago the rates of our company were being regulated.

1. Referring, probably, to the decision of the United States Supreme Court in the "Standard Oil case" (Standard Oil Company of New Jersey v. United States, 221 U. S. Rep., 1).

2. Mr. Alfred L. Baker, a citizen of Chicago who has manifested much interest in plans for civic betterment.

A Boiler Room at Northwest Generating Station of the Commonwealth Edison Company, Chicago

One of the self-constituted bodies which thinks its principal business (and probably rightly so) and the most serious function that it can perform is to assert all the authority and none of the responsibility of municipal government — this organization requested me to appear before it and justify our rates. I had such a good time that I asked to be elected a member of that body, and I was "turned down." Why? Because I am a public-service-corporation official. That shows the attitude toward public-service corporations.

I think it was last spring that we had quite a municipal campaign here. As is usually the case when a subscription list is going around, I was asked to subscribe, I think, to both sides of that campaign. I subscribed to one, and after the campaign was over, my money was returned. Why? Because I am a public-service-corporation official. I think that shows the general attitude of the community toward public service.

If you will trace that down, I am inclined to think it is largely owing to the general hostility that used to exist in the community toward corporations. It was largely centered on the railroads and the local public-service corporations. That has grown less as the shoe has pinched a little harder, and some of our friends in the industrial world have come more or less in contact with the government, whether it is state or interstate or local.

Cheap Money Means Low Rates

It strikes me that the place where a movement to correct matters of this kind should be started is in a club of this kind. From the figures I have mentioned you must see the importance of the public service to a community like Chicago. If the hostility to the public service results in its being difficult for the various corporations operating the several branches of public service to obtain money, it means that the cost of service must be higher. If you have a strong agitation against your gas company; if you have an unseemly controversy such as we have seen for the last year in this community with reference to the telephone company; if you have matters of this kind treated

as questions of politics, where the interest of the man attacking the industry is largely that of tearing it down with the idea of building himself up,—it matters not how brilliant may be the inventions brought into use, you will of necessity have very high cost of service because, after all, the cost of money is the largest item of expense in figuring the cost of any public utility in any community.

That is a matter which rests entirely with the community. If you want low cost of service, if you want to get the largest amount of service in transportation out of a nickel, if you want to get the largest amount of energy out of the dollar, if you want to get the cheapest and best communication out of the money invested by the telephone company, you must put those various services in condition to obtain their money in the markets of the world at the lowest possible price; and that you can only do by judicious regulation and by fostering those industries instead of fighting them.

The Question of "Home-Rule" Regulation

It is on this subject that I want to appeal to the members of the Commercial Club especially. There has never been a time since the early days of civilization that brains have not been in control. While we are subject, and universally subject, to law, we are subject to a system of regulation here that is an absurdity. But there is no reason, if the influence of bodies like the Commercial Club is exerted in the right direction — if they will consider corporate property as sacred as the property of the individual — there is no reason whatever why you should not have the cheapest service in this community, because to my mind you have the greatest opportunity.

To go to the subject of regulation, the question of "home rule" in this community has been ridden to death. Some years ago some distinguished uplifting friends of mine, went down to Springfield and put the control of the principal public-service bodies in Chicago under the control of the City Council.

I am not speaking against regulation and control. I was

one of the first men in my line of business to recognize, some fifteen years ago, the futility and the destructiveness to capital and the destructiveness to cheap service, of competition as a means of regulation, and urged my brethren in the public-service business throughout the country to support governmental regulation.

How are these industries regulated here? They are regulated in campaigns for the election of aldermen to the City Council, when you come down to the finality of the thing. It is not a question of a man's ability to deal with the technical subjects that come before him; it is a question on the one side of a man being able to deliver the greatest number of speeches to get the greatest number of votes, and, on the other side, of proclaiming that he is the only honest man in the community. It is this class of men who regulate $450,000,000 of capital, 60 to 70 per cent of which is owned right in this community and commonwealth, whose business is vital to the success of the community, and whose constant flow of money into this community in the way of additional investment from year to year is a very important factor in the industrial enterprise of the city of Chicago.

Problems that Should be Dealt With in a Business-like Manner

Notwithstanding the situation here, notwithstanding the troubles that exist, we have been able to accomplish some things. We have heard at different times a great deal about conservation, appealing to the imagination by talking of making two blades of grass grow where one grows at present. But while the cry for conservation has been going on, we have managed in this community to get along with half a pound of coal in our electric generating stations where we used to get along with a pound. If we were using the same amount of fuel today that we were using ten years ago, it would make a difference yearly of 1,500,000 tons being taken out of the existing coal supply of Illinois.

I am naturally more familiar with my particular branch of the business than I am with the other branches of public service, and I simply mention the fact of increased fuel economy merely to illustrate my position. The same class of improvement has gone on from year to year in every other branch of public service.

There are few cities in this country where you can ride as far for five cents as you can at the present time in this city, and if the municipal officials of this city are seriously anxious to obtain still further concession in that direction, there will be no trouble whatever to get them within the next few months, if they will leave politics out of it and simply deal with the question as a business proposition.

The influence of the members of this club in that direction, to see that things are dealt with in a business-like manner, to see that the public service is protected and fostered just as much as you would protect and foster any other branch of usefulness in this community, will, I am sure, greatly add to the prosperity of Chicago and to the benefit of its citizens.

THE NAME OF EDISON A TALISMAN[1]

IT IS an especial pleasure to me, apart from the pleasure of again addressing my associates in connection with the business of H. M. Byllesby & Company, to rise and thank you on Mr. Edison's behalf for this magnificent audience, an audience of appreciation of his visit on the occasion of the tenth anniversary of H. M. Byllesby & Company.

I need only mention the fact that when you came in here this evening I had to explain to him that the splendor of this banquet and the large attendance of so many of the prominent men in this community were tributes to him and to his great work. I tell you this to give you an illustration of the marvelous modesty of the man whom I consider the greatest private citizen of the race today.

To talk of his achievements — I certainly can do that in his presence, for he cannot hear what I am saying — I have simply to point to the striking fact that much of his work has been in the direction of recording and reproducing the utterances of the human voice, whether mechanically or electrically, and it stands as a proof of a marvelous capacity for work on the part of a man who found it most difficult to hear the results of his own experiments.

His achievements, whether we take one particular branch of the electrical industry, in which one or the other of the men bearing these names you see around this room have been conspicuous, or whether we run the whole gamut from the early

1. Thomas A. Edison was a guest of honor at a banquet given by H. M. Byllesby & Company at the Congress Hotel, Chicago, on January 5, 1912. The dinner followed the third convention of the organization. Mr. Byllesby, the toastmaster, proposed a toast to Mr. Edison, which was drunk standing and with great enthusiasm. Mr. Edison does not make public speeches, and Mr. Insull responded for him on this as he has on other occasions.

days of telegraphic invention to the modern-day work — the inventions in connection with the production and distribution of electrical energy — have surpassed in practically every branch the work of any one man in any particular branch.

What Edison's Work Means to the World

It is nearly forty years since Mr. William Orton, the president of the Western Union Telegraph Company, stated that the result of the invention by Edison of his quadruplex system was to create in one year, a year in the early seventies, phantom circuits, the value of which, had those circuits (of poles and wires) been erected along the highways and byways of the country, would have represented in that year an expenditure of $2,000,000, and I think in the next year $3,000,000.

I simply mention this to show you that long before many of you younger men were born, Mr. Edison had done enough work to place his name securely in the niche of fame, and at that time, practically as a lad (he was twenty-six years old) he had scarely commenced his career and his work. Now as a man of sixty-five he works with the same enthusiasm, the same devotion and the same ambition to achieve, that signalized his efforts in the early days of electrical experimentation.

I think in no part of this world to which the efforts of modern industrialism have pushed themselves will you find a country where the name of Edison is not a household word.

But it is not my intention to dwell long upon the praise of his achievements. There is only one other branch of his work that I wish to refer to, and that is the marvelous work that he did in connection with the generation and distribution of electrical energy and the development and establishment of what we to-day call the incandescent-lighting system.

It is not possible for any of you engineers in this room, whether you may be engaged in electrical illumination, in laying out the steam or electrical distribution of a factory, in the building of an urban or interurban, or interstate system of transportation — I say it is not possible for you to lay out

engineering plans in which you make use of Edison's original distribution ideas, as set forth in his early patents and his various systems (which are the best practice today and which will be used, in the judgment of all of us, for all time in connection with the distribution of electrical energy), without recognizing the marvelous engineering ability of the man. This is not merely the ability of a haphazard investigator or inventor, but the marvelous engineering ability that led the great originator, over thirty years before many of the things were put in use, to place in the records of the United States Patent Office the very specifications which you yourselves are compelled to use in this year of grace 1912.

As I told you, I prepared no set speech for this occasion. And sitting here beside him this evening, sitting here beside our old chief and friend, I have asked him to give me a few ideas that I might read to you.

Some of Edison's Aphorisms

Edison says: "It will not be many years before the public will hardly know what coal is. Its use will be segregated in vast power houses, and to the ordinary individual it will become a curiosity, as all users will obtain their light, power and heat from electrical distribution stations."

Another one from Mr. Edison: "When you consider the electric motor has but one single moving part and that that rotates, it is safe to say the electric motor will move the world."

Yet another: "In a few years all the railway terminals in the large cities will be electrified. In all mountainous countries where there are water powers, the main lines will be electrified, and ultimately"— and I would like to alter that word, and say very nearly, very early —"the advancement of science will be such as to cause all railroads to be run electrically."

"All vehicle traction in cities will in a few years be electrical for the reason that the electric motor has only one moving part and that has a rotary motion, whereas a gasoline truck has two hundred moving parts."

I have been very much in the habit when addressing people connected with H. M. Byllesby & Company to appeal more especially to the young men. I prefer to address myself to the young men because I am still foolish enough to think I am nearer to them than I am to the old men. And in addressing the young men I do not know any better subject, any better name to point to, than this talismanic name across the hall[1] which it has been my privilege to work under for upwards of thirty-three years.

As I have often told you, and told my own people with the Commonwealth Edison Company, it is not possible for all of you to get to the top; it is not possible for all of you engineers to become Edisons; but it is possible for you to use the general scheme, follow out the general scheme, to have the same ambitions, to have the same power of continuously sticking at a thing that Mr. Edison has himself. I remember once sitting in his laboratory, at a time when I was his private secretary, when a gentleman called on him and introduced his son and said: "Mr. Edison, I wish you would give my son some motto to remember." In a flash Mr. Edison turned to the young man: "Young man, never look at the clock." I would add to those words and say: "Never look at the clock except in the morning."

I asked Mr. Edison to write down some message to the young men here, and I will read it to you. It is in his own handwriting. He said: "When you get a job, pitch in, pay no attention to time. Get more interested in the business than the old man himself. Think of nothing and talk of nothing but shop. Then when you want to leave to better yourself the old man won't let you. He'll raise your salary or take you in as a partner."

Concentrating the Production of Energy

Before I take my seat I would like, as I always like, to blow my own trumpet a little bit.

1. Referring to the name of Edison in letters of light on the balcony of the banqueting room.

It was my privilege this afternoon to take Mr. Edison to our two power houses down here on the Chicago River and to remind him of the time thirty-one years ago [March 1, 1881] when it was my privilege to be shown by him the first central station in the world. He said: "How it has grown since then! Of course it has grown beyond all we expected. I never dreamed we would have more than 10,000 horse-power units." I think at the time he showed me his plant he probably had about 10 horse-power units, or maybe 20 horse-power units. I felt very proud in showing him through our stations and the work that had been accomplished in the last few years. He asked me something about the figures. I told him ten years ago we had 30,000 horse-power. Three years ago we had about 150,000 horse-power and last night we had a load of 300,000 horse-power.

That gives you some idea of the great growth that has taken place in this community. But if you will place parallel to that the growth that has taken place in the various plants and corporations controlled by H. M. Byllesby & Company, which to a very large extent are located in centers where the growth in population is far greater than it is in Chicago, you will find that those figures, although they may sound very large when the fact that they exist in one great central station, or rather in one great centralization of power in one state is considered, are relatively small in comparison with your own figures. I asked Mr. Edison what he thought would occur in the next ten years or twenty years in our line of business. He said that he thinks within our own time practically every wheel of industry, practically every wheel of transportation, will be operated from a central station.

I am firmly convinced of this from our experience here in Chicago. It is not an economical proposition to produce energy for use in a community—in any district, we will say, with any considerable density of population — except under one organization.

That is the course toward which we are working. You young men here have far greater opportunities for achievement

with the work that must take place in the next twenty years than those of us who have been engaged in this business for the last three decades.

All I ask of you is to take that name (indicating the name of Thomas A. Edison) as your inspiration, as those of us who are in prominent positions in this business today have been fortunate enough to take it during the last thirty years.

THE RELATION OF CENTRAL-STATION GENERATION TO RAILROAD ELECTRIFICATION[1]

I AM NOT going to discuss the question of the practicability of steam-railroad electrification. That is not a matter at all within my province. That is a matter that has to be decided by those great captains of industry who are in control of the vast transportation companies in this country from the Atlantic to the Pacific. But it is reasonable, as a central-station man, that I should assume that the electrification of steam railroads has come to stay; that the work done by the two premier trunk lines centering in New York is a sufficient indication of what we may expect in the future. I am not in sympathy with an agitation to force the steam railroads in this country to electrify. That is a question of the provision of the capital necessary for the purpose, and that question must be taken up and settled by those who are responsible for the operation of the railroad properties. Nor am I going to discuss what might be termed the technique of the electrification of steam railroads; that is, the special system that should be used, whether it should be done with one class of current or another, or one pressure or another. The system finally decided on must be the one which fills conditions of railroad operation, and at the same time renders it possible for the railroad com-

1. One of the most important of Mr. Insull's addresses was that delivered before the American Institute of Electrical Engineers in New York on April 5, 1912, and reprinted here. President Gano Dunn presided at the meeting, introducing first Mr. Frank J. Sprague, chairman of the railway committee, who had requested Mr. Insull to give the Institute the results of his experiences. Mr. Sprague spoke in laudatory terms of the work accomplished in Chicago by Mr. Insull and his associates. An animated discussion followed the presentation of the address, and a brief account of the debates in both New York and Boston will be found on subsequent pages.

pany to take advantage of the sources of energy supply already existing, as the railroad demand is only about 15 to 20 per cent of the total demand for energy in any community. That amount of energy which the railroads require to operate their properties is really the thing that should turn them to central-station men for assistance, and I speak as a central-station man.

The amount of energy required to operate the terminal and surburban systems of all the trunk lines centering in and around New York city (as I think I will be able to demonstrate to you) is, I believe, less than the amount of energy required to operate the isolated electric-lighting plants in the same territory. It is not a serious proposition. To my mind it is of less consequence to the properly operated electricity-supply company than the isolated-plant business was to the electric-light-and-power companies through the country twenty years ago, or even fifteen or ten years ago.

A Question of Economics

The problem of the relation of the central station to the generation and primary distribution of energy, so far as the steam railroads are concerned, is a question of economics. It cannot properly be considered without taking into account the entire question of generation and primary distribution for any given center of population. If you consider steam-railroad electrification by itself, the amount of energy required seems to be very great indeed. If you consider it merely as a fraction of the supply of energy required by a community for all kinds of purposes, it is found to be simply an incident. Perhaps a more accurate title for this paper would be "The Generation and Primary Distribution of Energy for Given Areas," because that is the real question involved. It is not a new subject; it is a subject dealt with at great length in the presidential address of 1910 by my friend Mr. de Ferranti, when addressing our sister organization, the (British) Institution of Electrical Engineers. Mr. de Ferranti went farther than I am going in this discussion. He proposed a scheme of generation and distribution for the whole of Great Britain. He proposed a scheme that meant, in his

opinion, a saving of 80,000,000 to 90,000,000 tons of coal a year for Great Britain. If the plan, which you must necessarily admit is reasonable, after studying the maps and curves presented, were adopted in this country, my judgment is that it would mean the greatest conservation of one of the most important natural resources of the country, fuel, to the extent, probably, of from 100,000,000 to 150,000,000 tons of coal per year.

The method of concentration of generation and distribution of primary power, as I said, is not a new subject. It has been an absolute necessity in all the smaller communities of this country. First, in the small communities they formed companies to do the public lighting; next they added to that the incandescent-lighting business; a little later they added the power business; then they connected up two or three small towns together; and today the average prosperous small local company supplies energy not only for lighting, whether for domestic or commercial or public purposes, but for power, for pumping water, and for the urban and interurban transportation, and as a result has raised its load factor from about 20 per cent, when it was engaged solely in the lighting business, to from 40 to 50 per cent today. That method of concentration of generation is going on to such an extent in the smaller communities throughout this country that I know of cases where, in an area of 15,000 square miles, that is, an area 150 miles one way by 100 miles another way, they seriously have in contemplation doing away with possibly 100 to 120 generating stations, and replacing them with ten or twelve stations.

Taking Energy from One Source of Supply

Where there are large water-powers adjacent to the larger cities, you find no hesitation on the part of the railway company, the electric-light-and-power company and the electrified steam-railroad company, if there be such in that vicinity, taking their energy from one source of supply. Is there any reason why the power generated at Niagara Falls can be used alike for all these enterprises, whether they be local public-service enter-

prises, state public-service enterprises, or interstate enterprises — is there any peculiarity about the fact that the power is generated hydraulically? Is that any special reason why these various industries should all take their energy from a given source? Is it not just as reasonable that they should all take their energy from a given source, if that power is supplied from fuel, from coal, with steam turbines as the prime movers, as that they should do this when the power is supplied from water with hydraulic turbines as prime movers? I cannot see any reason, if concentration of production is the correct principle in one case, why concentration of production is not the correct principle in every case.

I have naturally taken for the purposes of my discussion the information which the engineers of public-service enterprises in New York have placed at my disposal, together with the information that I naturally am able to obtain from my own operations in Chicago. The conclusion that I have come to is that the concentration of the production of energy, for all purposes required in a given area about any large center of population, would result in such a saving in capital and such a saving in operating expenses as to provide sufficiently for the generating capacity and primary transmission systems necessary to electrify the terminal systems and suburban service of all the trunk lines centering in and around that center of population. Particularly is this true in the case of New York. Furthermore, the saving would be such as to yield very large profits, in addition, to the engineers and financiers having the courage to handle so great a problem.

The *percentage* of saving is comparatively small. On a percentage basis I may say that the percentage of saving in Greater New York (and in "Greater New York" I include that part of the Jersey shore that would naturally be considered a part of a Greater New York) is comparatively small, and to my mind somewhat disappointing, owing to peculiar conditions which I will explain later. But the saving itself is so large and amounts to such a great sum of money, capitalized, that I cannot see how it is possible, whatever may be the jealousies of

management, and whatever may be the individual interests of the financial people operating the various properties — both as engineers desiring to get the greatest possible results out of their work, and as capitalists wanting to supply the greatest possible amount of service at the lowest possible cost to the public and the greatest possible profit to themselves — I cannot see how either the engineers or the financiers can neglect the subject and let it pass by, as it is one of the greatest opportunities I know of in our business.

The New York Situation

To take up now the illustrative curves, Fig. 1 is the New York total-load diagram. It includes the present electrical load of the central stations in Greater New York and the central stations on the Jersey shore, within a radius of ten or twelve miles of New York, operated by the Public Service Corporation of New Jersey, and the station of the Hudson and Manhattan Railroad Company.

The diagram includes only that portion of the load of the electrified steam roads which has already been electrified, and does not include an estimate of the load of the isolated plants. If the remainder of the load of the electrified steam roads and the isolated-plant load were included, the total would be in the neighborhood of 1,000,000 kw.[1]

Looking ahead, if you take the New York maximum of 676,000 kw. and apply an 8 per cent annual increase (the actual increase of this maximum over the previous winter was 7.5 per cent), at the end of eight years the New York maximum would amount to 1,250,000 kw., and at the end of ten years to 1,480,000 kw.

If there be added to these figures the isolated-plant and steam-railroad demand, it makes about 1,000,000 kw. of load at the present time. The steam-railroad demand would be about 170,000 kw. of that total, and the demand made by isolated plants would be 217,000 kw.

1. In this paper the abbreviation "kw." is used for "kilowatt" or "kilowatts."

The total load of the systems separately is 678,000 kw., and there is a diversity factor that would reduce that if they were

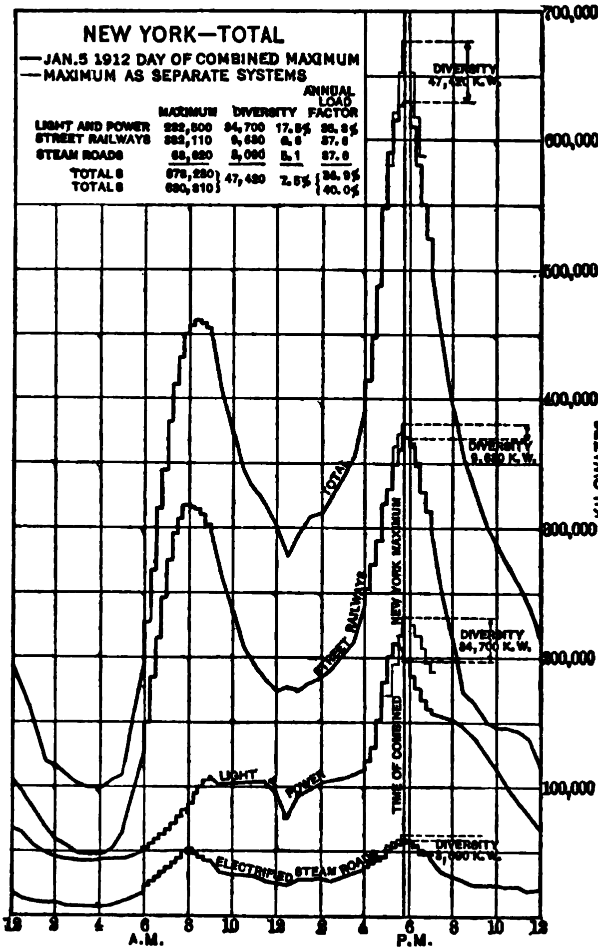


Fig. 1

all run as one system; that is, if the present business of the lighting-and-power companies, the street railways and the steam railroads were combined, the maximum load this last

winter would have amounted to 630,000 kw., or a saving of upwards of 47,000 kw. The diversity factor amounted to 7.5 per cent, and the load factor would have been improved from

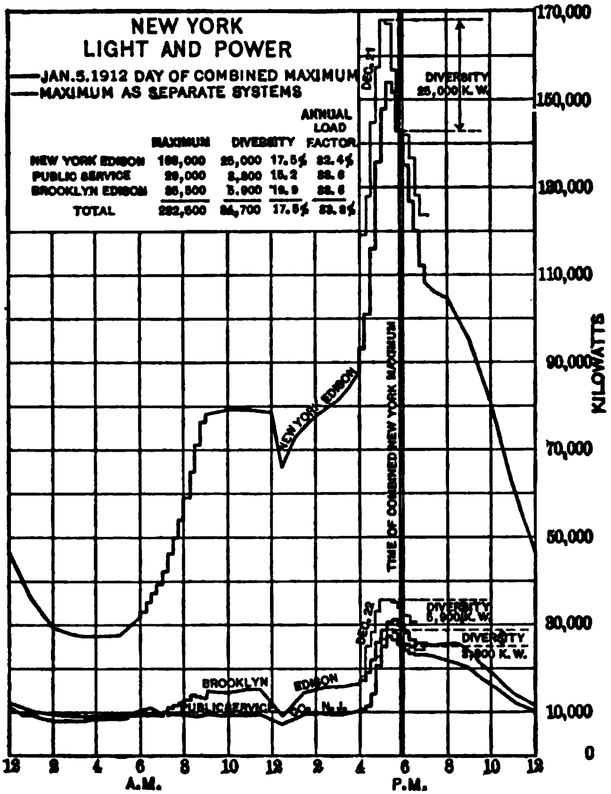


Fig. 2

36.9 to 40 per cent. Later, I will explain some of the advantages obtained from that.

Fig. 2 is the New York light-and-power load diagram. The New York Edison Company curve includes the load of the United Electric Light and Power Company and also the Bronx load. The Public Service Corporation curve includes that

company's light-and-power load only, its street-railway load being on the street-railway curve.

The total load is 232,500 kw. The load factor of the various

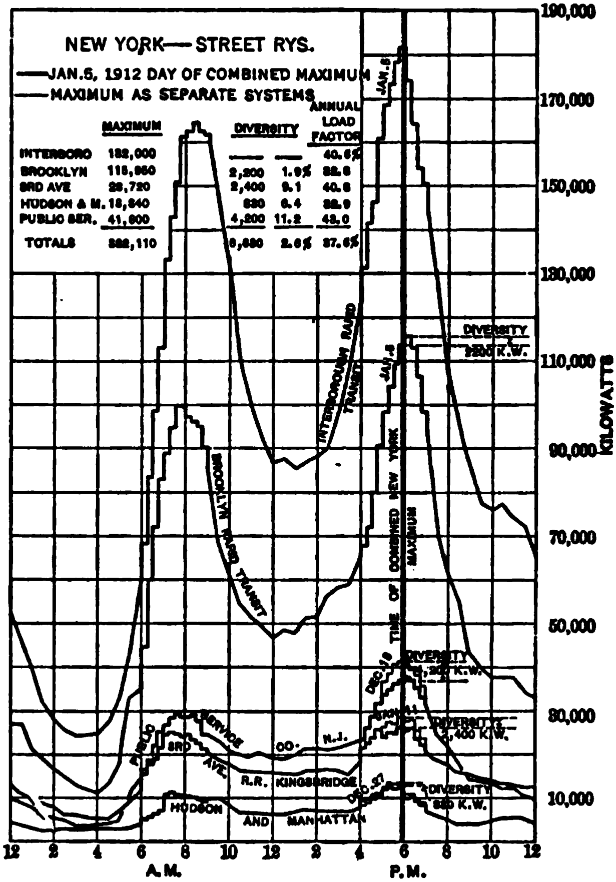


Fig. 3

systems by themselves is 33.8 per cent. There is a diversity of 17.5 per cent, amounting to 34,700 kw., between the sum of the maxima for the year of these different lighting companies and their load between 5:45 and 6 p.m. on January 5, 1912,

which was the time of the maximum for all the New York companies combined; that is, the lighting, the street-railway and the electrified steam-railroad companies.

Fig. 3 shows the load diagram of the street railways of New

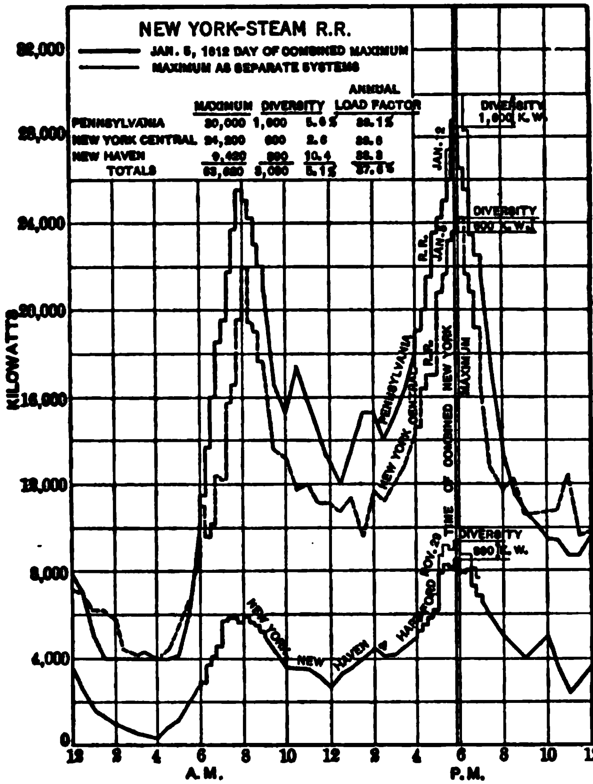


Fig. 4

York city. The Interborough has much the largest maximum of any of the New York companies, and therefore establishes the day and hour of the combined maximum, and there is no diversity between the Interborough load and the combined maximum. The diversity between the three power houses,

subway, surface and elevated, of the Interborough has not been taken advantage of, and possibly amounts to a considerable figure. What is meant by that is that I have not taken advantage of it in making these diagrams, because the interests having charge of the street railways, I believe, have already taken advantage of it by connecting up their various power houses, so as to get the advantage of the diversity factor.

Fig. 4 shows the load diagram of the steam railroads entering New York city. Due to the electric heating of the suburban cars, the New York Central maximum occurs on the same day as the Interborough and the combined maximum, and the Pennsylvania maximum, for the same reason, only a few days later.

The present electrical load for the passenger service of the steam railroads of New York is estimated at about two-thirds of the total load if all of the passenger service within a reasonable radius of, say, fifteen to twenty miles of New York city were electrified. This would give for New York a total electrified passenger load of 95,000 kw., as compared with our estimate for Chicago of 73,000 kw., which appears reasonable. If to this we add 75,000 kw. for freight, as compared with our estimate for Chicago freight of 78,000 kw., we get a total for the electrified steam railroads in the vicinity of New York of 170,000 kw.

Attention might be called to the fact that the farther out the steam railroads are electrified, the less influence the suburban service will have, and therefore the greater the diversity factor.

There is a very important point I wish to emphasize, that has a bearing on this subject only in the large centers of population where there is heavy suburban travel. The same thing will be shown in some of the curves to follow. These two maximum loads, morning and evening (Fig. 4), are made up of suburban business, and the suburban-railroad load maxima are largely affected by the heating proposition, and also the large amount of power needed additionally for traction in cold weather. That condition cannot possibly exist except in a few, perhaps a dozen, cities of the United States. The steam-

railroad load factor is relatively poor in those centers, but if you will take the average business throughout the country where our central stations are in cities, say, of the second and

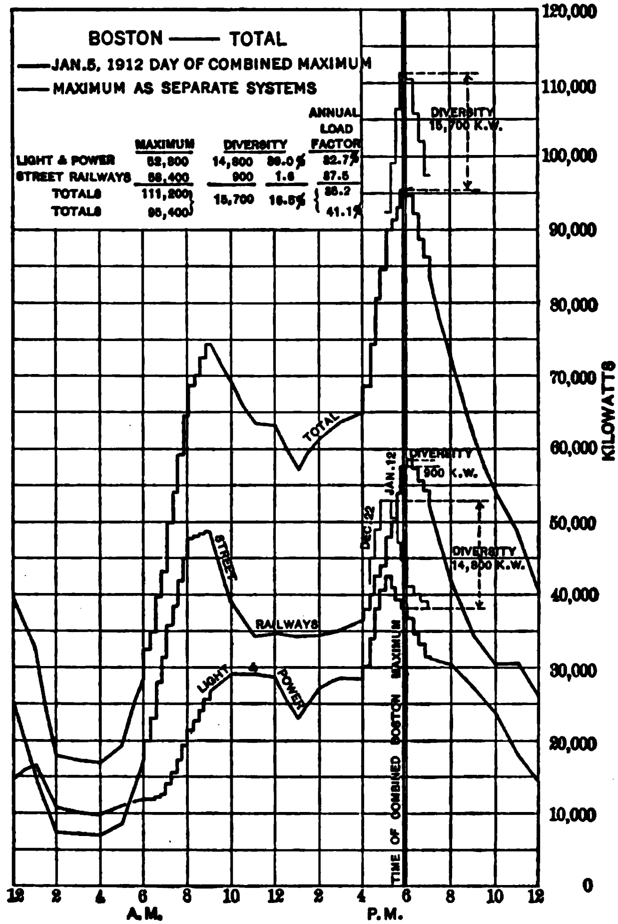


Fig. 5

third grade, the steam-railroad load would show a very much better load factor, as there is practically little or no suburban business in any cities except the very largest cities of the country.

The Boston Situation

Fig. 5 is the total-load diagram of Boston. The street-railway curve is the Boston Elevated Railway Company load, which includes the subway, surface and elevated roads. The Edison light-and-power load is also given.

A careful estimate of the electrical requirements, for the passenger service only, of all the steam roads operating within the metropolitan district of Boston, has been made, but as the figures do not include freight, and also for the reason that the larger portion of it is based on 11,000-volt single-phase operation, which system practically eliminates the possibility of showing savings in transmission and substation by combining with the other local power supply, I have not attempted to include load curves for the electrified steam roads. Also no estimate has been made of the isolated-plant load in Boston. The total rating of the Boston steam plants, 160,600 kw., amounts to a reserve on the combined load of 68 per cent.

It will easily be seen that there is a remarkable diversity between the loads of the street-railway and lighting-and-power companies in Boston. To me it seems almost incredible that there should be built a second large power station in Boston, when, if the service for both the lighting and railway were run by the same station, the maximum load last winter would have been 95,400 kw., instead of 111,200 kw., as there is a diversity of 16.5 per cent between the two businesses; and yet so blind are some people to their own interests that the financial men running the Boston elevated roads are actually throwing money away by building a plant for themselves right by the side of the plant of the Edison Illuminating Company of Boston.

The Chicago Situation

Fig. 6 shows the total-load diagram for Chicago. The diversity shown in the tabulation on this chart amounts to 72,260 kw., and would require, assuming a 25 per cent reserve, 90,300 kw. more capacity if operated as separate systems than if op-

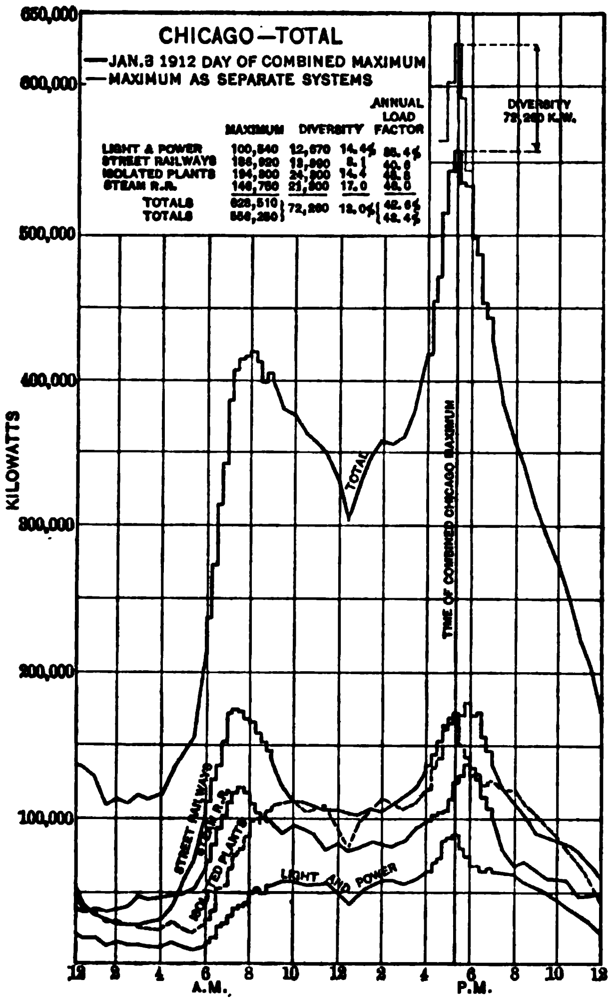

CHICAGO—TOTAL
—JAN. 3 1912 DAY OF COMBINED MAXIMUM
—MAXIMUM AS SEPARATE SYSTEMS
MAXIMUM
DIVERSITY
ANNUAL LOAD FACTOR
LIGHT & POWER
STREET RAILWAYS
ISOLATED PLANTS
STEAM R.R.
TOTALS
TOTALS
DIVERSITY
TIME OF COMBINED CHICAGO MAXIMUM
TOTAL
STREET RAILWAYS
STEAM R.R.
ISOLATED PLANTS
LIGHT AND POWER
KILOWATTS
650,000
600,000
500,000
400,000
300,000
200,000
100,000
12 2 4 6 8 10 12 2 4 6 8 10 12
A.M.
P.M.

Fig. 6

erated on a combined generating system. At $75 per kw. this amounts to an extra investment of $6,772,500.

The isolated-plant load, although showing a maximum 50 per cent greater than our present light-and-power load, I believe has been estimated conservatively low. A canvass of the number and size of isolated plants was made by the contract department of the Commonwealth Edison Company, and several checks on these figures were available, such as "The Engineers' Directory," the agents' knowledge of the field and the City of Chicago Boiler Inspectors' records.

In estimating this isolated-plant load, the separate maxima of the plants are assumed to be two-thirds of the rated capacity, and the load factor, that is, the ratio of the average kilowatts for the year to the maximum kilowatts, is assumed to be 25 per cent, the assumption being based on the fact that the actual load factor of customers on our wholesale schedule, representing a very large amount of business, is 26 per cent.

On account of the diversity between the different isolated plants, it is assumed that their load factor, if combined, would be equal to the load factor of the Commonwealth Edison Company's general light and power business; that is, 35.5 per cent.

To the maximum kilowatts and kilowatt-hours thus obtained are added a certain portion of the South Chicago Steel Works load, the refrigeration load, assuming that one-half the ice of Chicago is produced electrically, and the electric-vehicle load, assuming two-thirds of all horses replaced by electric vehicles. These latter two items, being off-peak loads, improve the load factor up to the figure shown, although they represent only 17 per cent of the total estimated kilowatt-hours of the isolated plants.

The increased investment necessary as between these systems being operated all as one, including steam railroads, and being operated as separate systems, taking the cost of generating plant plus the cost of the primary transmission system, would mean an expenditure of upwards of $10,000,000 to $12,000,000 more than if the work is done on one system. We have got reasonably well started in Chicago towards doing it on one

system. We have practically the most important part of the work, that is, the street-railway work, and we are trying there to do all we can to get the isolated plants out of existence. In the steam-railroad business, as may be seen from our estimates, in what is the greatest railroad center in the United States today, passenger, freight and transfer business combined, the amount of energy required for operating all of the terminal systems there is so small a percentage of the whole that it would seem unreasonable to think we will not be able to get that, as well as the business of the surface and elevated railroads.

The next diagram, Fig. 7, shows the load curve of the street railways of the city of Chicago. One interesting feature of this chart is that the highest maximum for two of the street-railway companies occurred in the morning of February 21, soon after the beginning of a very heavy snow storm, with a strong cold wind blowing and the temperature a little above 20 deg. Fahr. That chart is generally characteristic of the urban transportation business of a city of the size of Chicago.

Fig. 8 shows the load diagram of the electrified steam railroads of Chicago, assuming that the steam railroads in the vicinity of Chicago are electrified some time. It is a load diagram of the maximum for the year. The method of estimating all of the data regarding the load of the electrified steam roads of Chicago is given in detail in the appendix to this paper, on "Electric Power Requirements of Chicago Steam Railroads Electrified — 1911–1912," prepared by Messrs. Bird, Gear and Fowler.

The freight curve, you will see, has an extremely good load factor. The passenger business is governed by exactly the same conditions, only intensified, that govern the passenger business in New York city. I presume the curves of passenger business in New York, Chicago, Boston and Philadelphia would probably be all about the same, except that Philadelphia, Boston and New York ought to have some advantage from a much larger amount of pleasure business in the summer than we get in Chicago.

The extreme peak in the morning and evening is caused by

the suburban business, the extra amount of energy necessary at the time of extreme cold for traction purposes and the extra amount of energy necessary for heating purposes. If it were not for these two peaks, the load factor would even up better than it does, and yet, notwithstanding these peaks, the com-

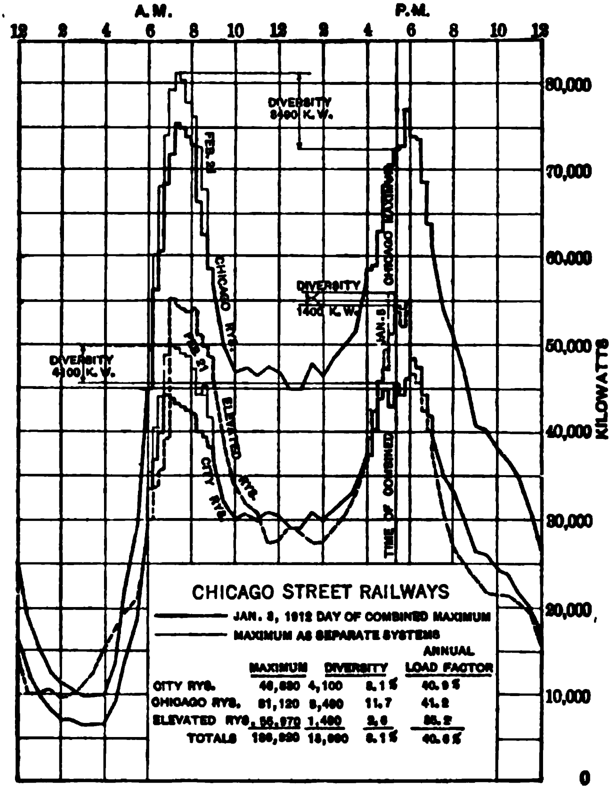


Fig. 7

bined freight and passenger business is estimated to have 46 per cent load factor. Now if we consider the steam-railroad business, say in cities of the size of Cleveland, Detroit, Buffalo, and possibly Rochester, Toledo, and similar cities, their load factors would be uniformly better than is shown in Fig. 8. In

my judgment the date of the maximum load, and the time of day of the maximum load, would probably change considerably, to the advantage of the local power company supplying the energy.

I thought it might be of interest to include a chart of the annual load factors of the Commonwealth Edison Company

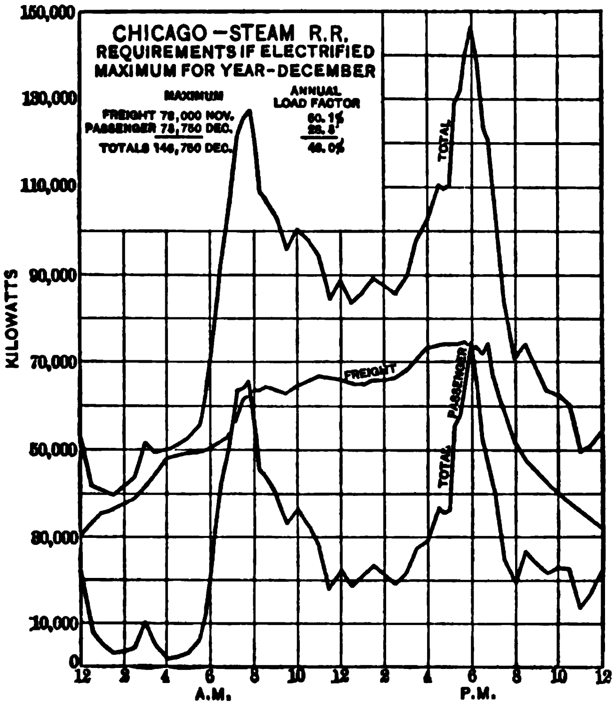


Fig. 8

for the last twelve years, as shown in Fig. 9. You will notice that the street-railway load factor went up and then dropped. It was at its highest for a few years just before one of the large street railways shut down its obsolete stations, which it had operated as "peak plants" only. This shutting down had also the result of earning it a very low price for the energy it purchased. The tendency of the railway load factor is to run

even. The tendency of the light-and-power load factor is to run up. The combined load factor, as shown in Fig. 9, is about 42.5. The light-and-power business by itself has a load factor a little under 35, and the street-railway business by itself about 43 per cent.

Taking Advantage of the Diversity Factor

Consider the diversity in a block of apartments. This diagram[1] has been used a number of times, both by myself and

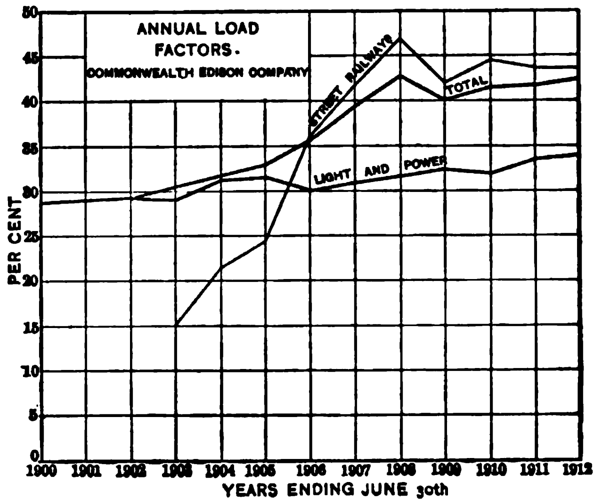


Fig. 9

by some of my subordinates in writing papers on different subjects where the question of diversity and load factor comes in, for it is a striking illustration of diversity. The drawing shows a city block composed of average apartments, much alike. Here are nearly 200 customers, all living in similar apartments, all of about the same class, all with about the same habits of life, and yet the difference in the load factor, taking each customer by himself, as compared with all of them put together,

1. In this collected edition of Mr. Insull's addresses this drawing is given as Fig. 1 of the address on "Centralization of Energy Supply," page 448.

is such that you get almost four times as good a load factor, and that is owing to the diversity of demand. That is the fundamental basis of the profit-making of an energy-selling company. We get that average in dealing with small customers and consequently we can sell these small customers at a profit as a whole, whereas any engineer who knew the facts could demonstrate to me that each one by himself is a loss to us.

It is exactly that same principle — I am getting down to the fundamentals, the A B C of energy production and distribution — that I and others who advocate the same ideas want to see brought about in all the electric-supply business, whether it is in large communities or small communities. I want to see somebody get the advantage of the diversity factor that exists. In one case, with small customers, it may show 400 per cent advantage. In another case, in a large community like the city of New York and surrounding territory, that percentage may be only ten per cent. But it runs up into millions of dollars, which is being thrown away today. I do not want to see those who are right on the threshold of entering into our line of business, the use of electrical energy, make mistakes owing to their ignorance of the real situation. I do not want to see them make the mistake that, in my judgment, largely through force of circumstances, the New York Central Company has made in building its present power house, and the Pennsylvania Railroad Company has made in building its power house, probably, I think, as much because they could not find people to sell them energy as because they did not know they ought to buy energy instead of manufacturing it.

Distribution and Load Factor

Fig. 10 is a map of New York city, with the present power-transmission systems. In referring to New York city, you will notice that I go out on the Hackensack River into New Jersey, as I consider that territory properly a part of the area included in the greater city for the purposes of the present discussion.

Fig. 11 shows the New York power-transmission system unified into one system. You will notice the difference be-

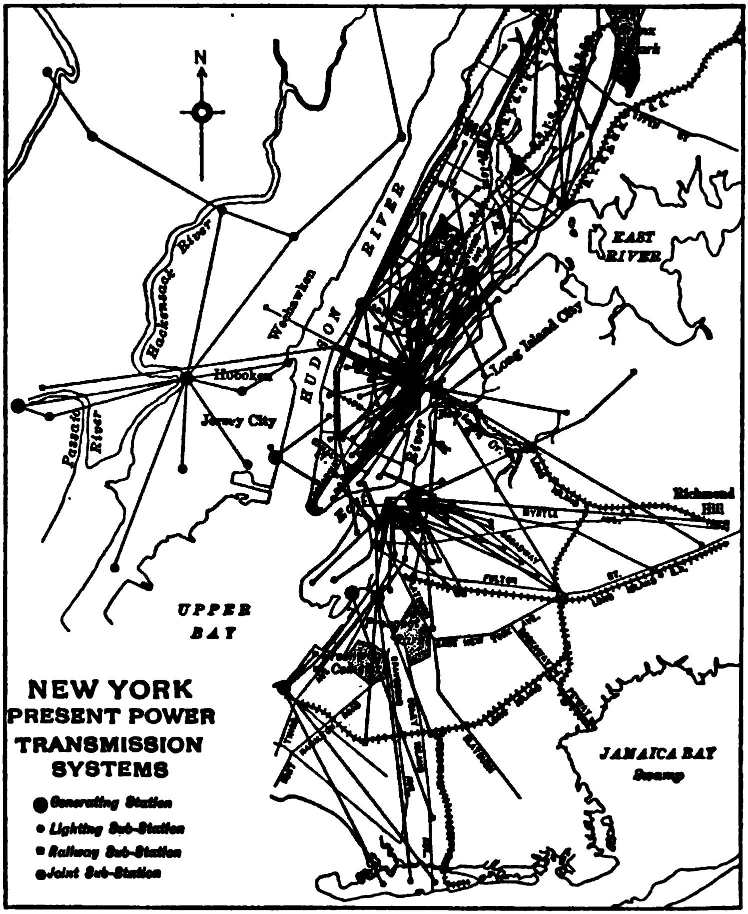


Fig. 10

tween the two. In Fig. 10 the number of substations and transmission lines is in marked contrast to the effective distribution in Fig. 11.

Fig. 12 shows the Chicago daily load factor. This diagram

shows the improvement in load factor as it affects operating conditions, the improvement being due mainly to the railway

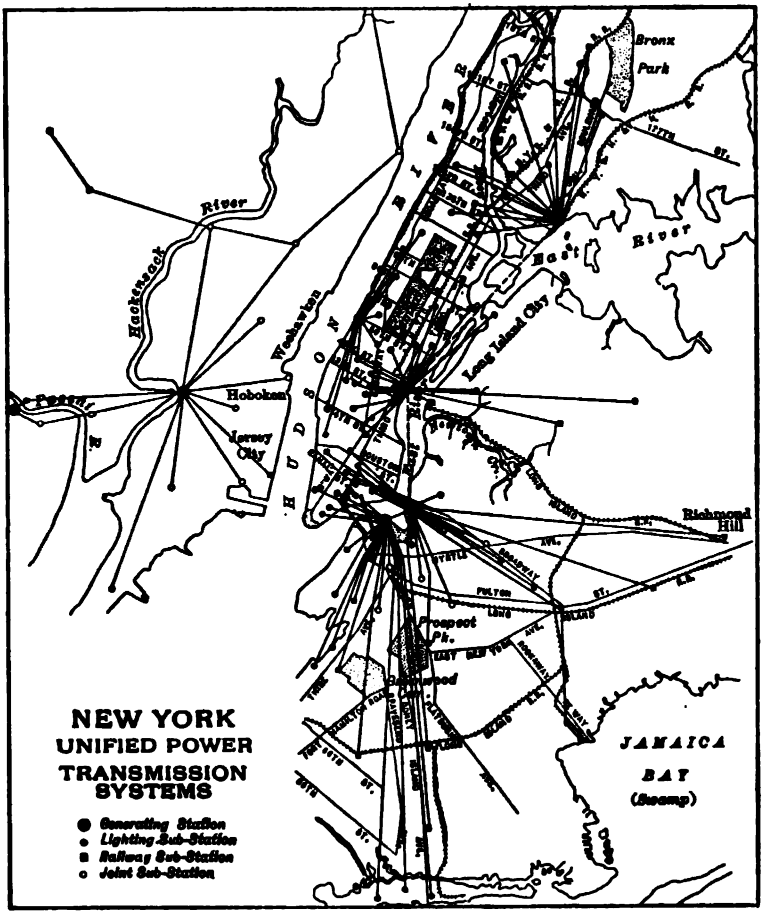


Fig. 11

load coming up earlier in the morning and the depression in the light and power load at the time of the evening railway peak. It is almost impossible to figure absolutely and closely this saving from concentration of production of electrical energy.

It is easy enough to figure the saving of investment, but it is pretty hard to figure the saving in operating expense. It is a very large amount, indeed, and the items especially affected are the items of what one might call "readiness to serve,"

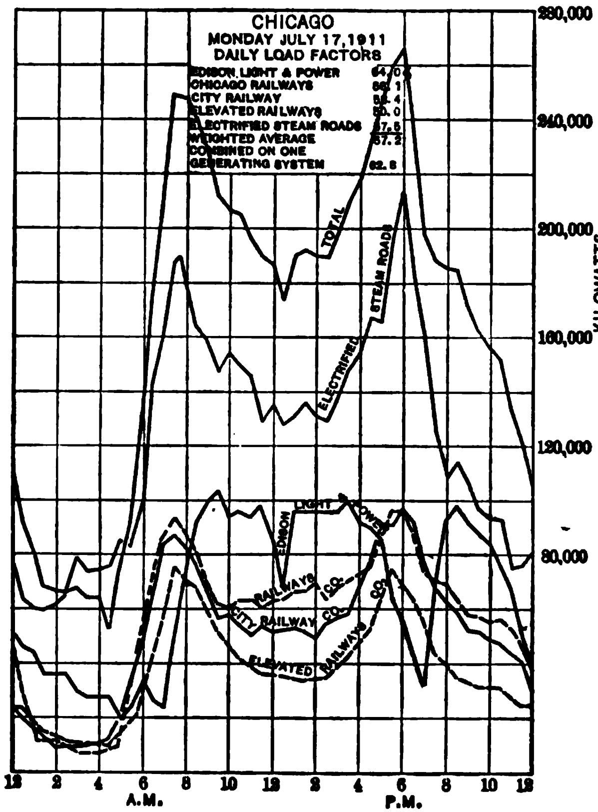


Fig. 12

including, of course, the expenses incident thereto. I do not refer to fixed charges but to operating expenses outside of fixed charges. Although it is easy to figure the saving in fixed charges due to diversity, it is not so easy to figure the saving due to the broadening out of this daily curve, but it goes a long

TABLE I—CHICAGO
DAILY LOAD FACTORS

	1911 Mon. Feb. 13	Wed. Mar. 15	Sat. Apr. 15	Tue. May 16	Fri. June 16	Mon. July 17	Thur. Aug. 17	Sun. Sept. 17	Fri. Oct. 20	Mon. Nov. 20	Thur. Dec. 28	1912 Wed. Jan. 3	Average of 12 months
Commonwealth Edison light and power	62.4	63.5	54.5	56.3	64.2	64	56.5	42.5	50.9	51.4	49.3	49.4	55.4
Railways Company (surface)	58.3	54.5	58.2	54.3	53.3	58.1	52.6	61.1	53.7	52.8	53.5	56.5	55.6
City Railway Company (surface)	57.5	52.4	55.3	59.8	48.4	53.4	49.1	66.9	51.5	61.1	60.2	57.6	55.3
Elevated railway companies	51.5	49.8	50.7	49.9	48.5	50.3	48.8	66.3	45.7	48.3	55.7	51.7	51.4
Electrified steam railroads	55.5	55.5	57	58.7	58.8	57.5	59.3	64.8	60.2	58.4	55.7	54.8	58
Weighted average of above	56.5	55.5	55.8	55.3	56	57.2	55	58.7	54.3	54.8	54.5	53.8	55.6
Combined on one generating system	60.7	59.1	64.3	57.6	62.2	62.8	59.8	61.5	56.4	58.3	58.6	57	59.9

TABLE II—BOSTON
DAILY LOAD FACTORS

	1911 Mon. Feb. 13	Wed. Mar. 15	Sat. Apr. 15	Tue. May 16	Fri. June 16	Mon. July 17	Thur. Aug. 17	Sun. Sept. 17	Fri. Oct. 20	Mon. Nov. 20	Thur. Dec. 28	1912 Wed. Jan. 3	Average of 12 months
Boston Edison	59.2	68.2	59.6	63.9	65.7	69.5	68.8	47.4	52.5	42.6	44.2	52.8	57.9
Boston Elevated	51.3	52.8	56.2	48.8	51.9	48.1	49.3	70	45.9	48.4	52.7	53.3	52.4
Weighted average of above	54.5	58.6	57.5	54.6	57.2	55.5	56.7	56.2	49.5	45.6	48.4	53.1	53.9
Combined on one generating system	54.8	62.7	63.2	66.4	67.3	63.4	66.3	56.2	49.5	51.6	55	56.1	59.4

way towards reducing the "readiness-to-serve" charges per unit produced in a given time.

In Table I is a tabulation of the daily load factors in Chicago. This expresses the matter a little differently. The

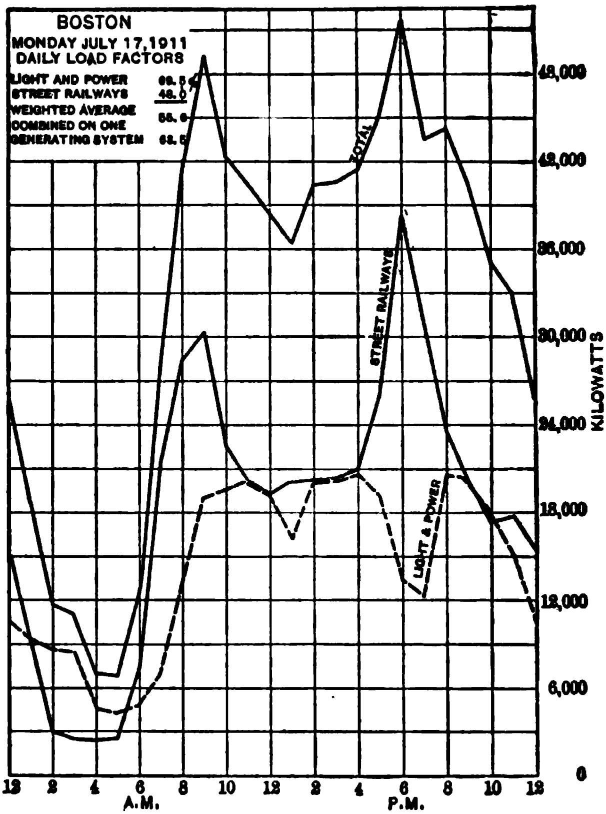


Fig. 13

average daily or operating load factors for the different systems operating separately, 55.6 per cent, is equivalent to thirteen and one-half hours straight-line or steady operation per day. The load factor for all combined on one generating system, 59.9 per cent, is equivalent to fourteen and one-half hours

TABLE III—NEW YORK
DAILY LOAD FACTORS

	1911 Mon. Feb. 13	Wed. Mar. 15	Sat. Apr. 15	Tue. May 16	Fri. June 16	Mon. July 17	Thur. Aug. 17	Sun. Sept. 17	Fri. Oct. 20	Mon. Nov. 20	Thur. Dec. 21	1912 Sat. Jan. 13	Average of 12 months
New York Central	48.0	47.4	46.8	43.2	45.6	43.9	44.3	63	40.5	43.3	45.7	44	46.3
New York, New Haven & Hartford.	52.4	49.8	56.2	50.9	49.5	47.2	51.2	50.1	50.3	48	48.8	53.2	50.1
Pennsylvania R. R.	58.4	54.4	57.8	49.3	51.6	49.9	47.3	64.8	54.3	49.1	49.9	53.3	53.2
New York Edison Co	52.1	57.6	52.8	57.2	58.5	62.2	61.7	46.8	48	42.3	44	45.7	52.4
Brooklyn Edison Co	49.6	50.7	44.4	46.9	45.3	45.7	48	43.6	51.2	52.2	48.5	49.1	47.9
Public Service Co. (Light and power)	50.5	47	40	46	42.6	46.2	47.3	39.5	46.8	43.5	45.3	48.8	44.9
Public Service Co. (Railway)	50.7	47	61.3	45.6	42.2	46.9	49.1	64	50	47.4	47.3	49	50
Brooklyn Rapid Transit	59.7	50.6	57	48.8	48.4	52.8	49.1	66.1	45.6	48.5	50.6	46.3	52
Interborough Rapid Transit	64.2	49.8	53.3	48.1	49.6	57.5	58.5	57.8	58.5	58.5	53.5	51.5	55.1
Third Ave. R. R.	70.6	54.7	58.5	52.8	54.5	63.3	64.3	63.5	64.3	64.3	59.1	56.6	60.5
Hudson & Manhattan	54.1	46.1	46.5	46.6	49.3	45.9	46.7	71.3	49.2	49	55.2	47.4	58.9
Weighted average of above	53.4	52.8	52.7	50.7	50.3	52.2	52	54	49.5	48.1	48	48.4	51
Combined on one generating system	53.6	54.6	64.4	58.7	58.7	60.7	59.4	63.8	49.6	50.2	50.6	50.1	56.2

per day, or an increase of one hour, or 7.4 per cent. This improvement means that the fixed-charge and "readiness-to-serve" portion of the operating expense is prorated over a greater number of units of output per day and per year.

You will notice, as shown in the table, the improvement in

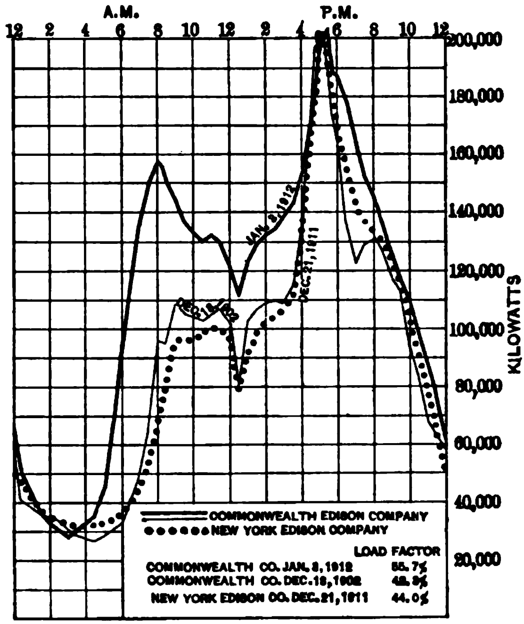


Fig. 14. Chicago and New York. — Load Diagrams for Maximum Day of Year Prorated to Chicago 1912 Maximum for Comparison.

conditions in each month in the year. The average shows a decided improvement if the systems are combined in one. The average is 59.9 and the average of the others, separately, is 55.6 per cent.

Fig. 13 shows a diagram of the Boston daily load, and Table II is a tabulation of Boston daily load factors. It is shown that there would be quite an improvement if the Boston Elevated and the Boston Edison loads were operated together. The

average is 53.9 per cent operated separately and 59.4 per cent if operated as one system.

Table III gives a tabulation of the New York daily load factors. It gives the same general character of information. Operated separately the stations show 51 per cent, and operated together 56.2 per cent.

Fig. 14 is a comparison of the Chicago and New York load diagrams. In this diagram the different load diagrams shown have all been prorated so that the maxima of all are equal and the same as that for Chicago for January 3, 1912. This method of comparing load diagrams shows just what hours of the day are affected by the improvement in load factor, and brings out perhaps more clearly than any other method the great advantage from an operating point of view of the combining on one generating system of the energy supplied for different purposes. This improvement, for instance, for Chicago as compared with New York, has a very decided effect upon the operating cost, and is one of the principal reasons for the very low generating cost in Chicago.

The effect of diversity on the peak, which results in a saving in investment, can be and has been very readily figured. But the effect of this diversity in reducing the operating cost cannot be so readily calculated. Nevertheless, there is no doubt that the saving in operating expense is fully as important as the saving in investment.

Some of the Results and Possible Results

Fig. 14 was prepared to show exactly the result of the policy the Commonwealth Edison Company has pursued in Chicago for the last ten years. It was just about ten years when we commenced to sell energy at prices that most of the producers of energy in this country thought were so ridiculously low that it was only a question of time and the size of our pocket-book as to how long we could stand it. This diagram shows you the result we have been able to obtain. As a contribution to our fixed charges, as a contribution to our stand-by charges, as a

means of producing more kilowatt-hours in a given period, so as to provide us with the necessary funds to adopt a reasonably bold policy of selling energy, in ten years we have been able to attain this result.

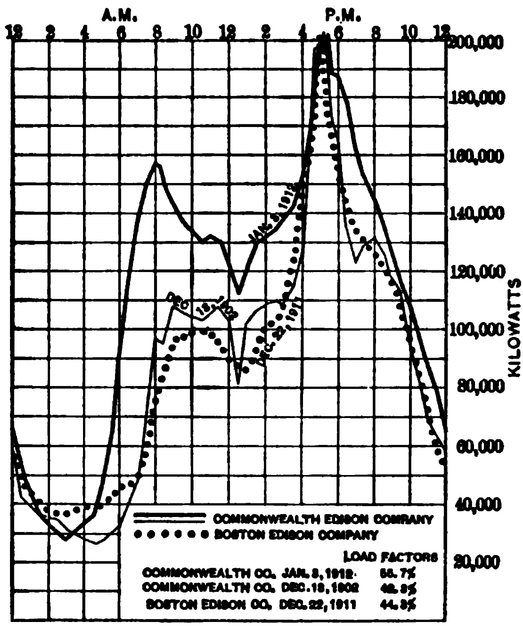


Fig. 15. Chicago and Boston.—Load Diagrams for Maximum Day of Year Prorated to Chicago 1912 Maximum for Comparison.

Fig. 15 is a comparison of the Chicago and Boston load diagrams.

Fig. 16 is a map showing the Chicago railroad terminals in the proposed electrical zone, the boundary of which was laid out by the Chicago Association of Commerce. The zone includes a territory about 32 miles long, with an average width of ten to twelve miles.

Fig. 17 is a map of the electrification of steam railroads in Chicago, based on a plan of group operation; that is, a plan of

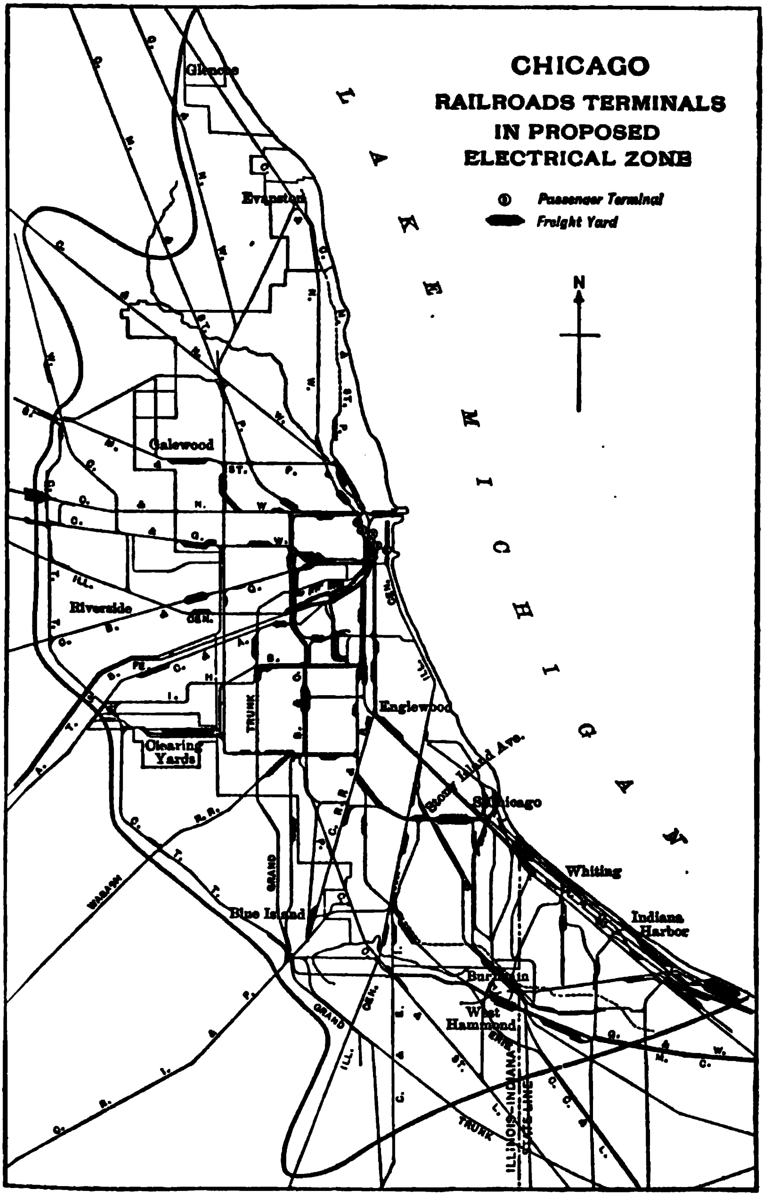

CHICAGO
RAILROADS TERMINALS
IN PROPOSED
ELECTRICAL ZONE
Passenger Terminal
Freight Yard
N
LAKE MICHIGAN
Glencoe
Evanston
Galewood
Riverside
Clearing Yards
Englewood
Stony Island Ave.
So. Chicago
Whiting
Indiana Harbor
Blue Island
Burnham
West Hammond
ILLINOIS-INDIANA STATE LINE
WABASH
GRAND TRUNK

Fig. 16

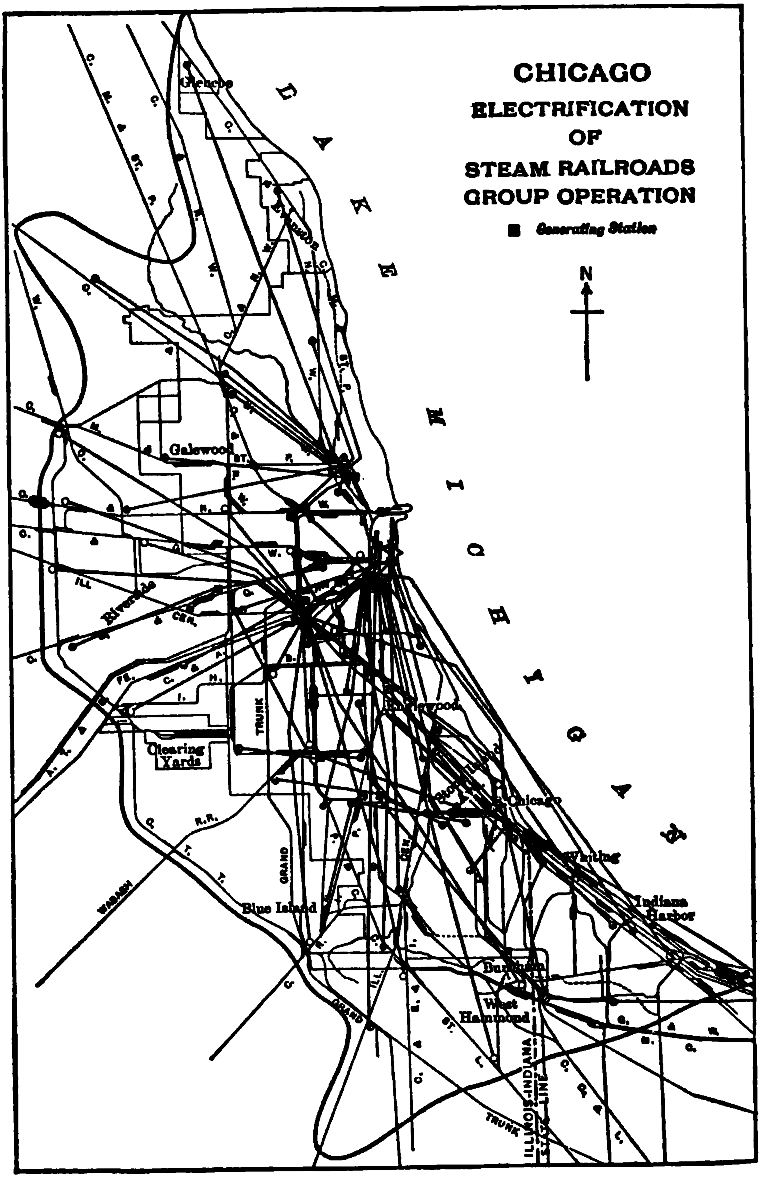

CHICAGO
ELECTRIFICATION
OF
STEAM RAILROADS
GROUP OPERATION
Generating Station
N
LAKE MICHIGAN
Glencoe
Evanston
Galewood
Riverside
Clearing Yards
Englewood
South Chicago
Whiting
Indiana Harbor
Blue Island
Burnham
West Hammond
ILLINOIS-INDIANA STATE LINE
WABASH
TRUNK
GRAND

Fig. 17

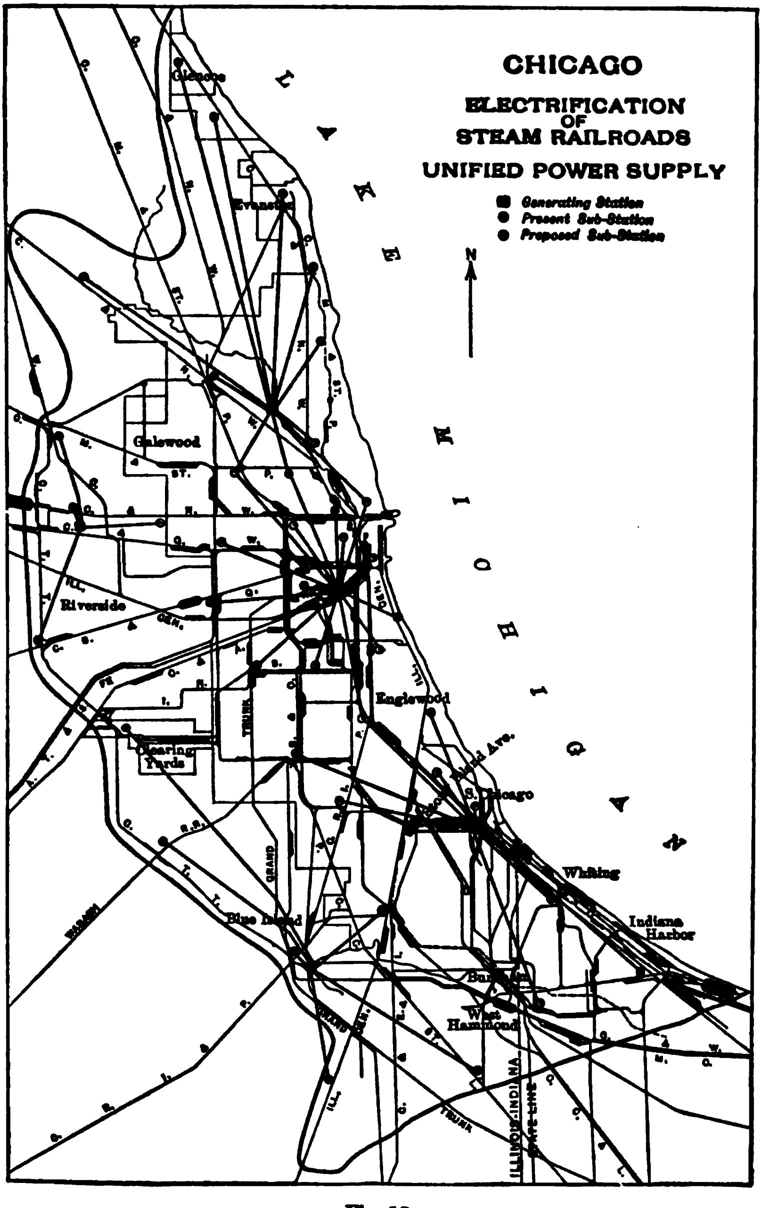

CHICAGO
ELECTRIFICATION OF STEAM RAILROADS
UNIFIED POWER SUPPLY
Generating Station
Present Sub-Station
Proposed Sub-Station
N
LAKE MICHIGAN
Glencoe
Evanston
Galewood
Riverside
Clearing Yards
Englewood
S. Chicago
Whiting
Indiana Harbor
Blue Island
West Hammond
ILLINOIS-INDIANA STATE LINE

Fig. 18

stations, substations and primary transmission lines on the theory that the railroads of the various financial groups, the New York Central group, the Pennsylvania group, and so on, would operate their power jointly, the idea being that the New York Central would have a system for itself, the Pennsylvania

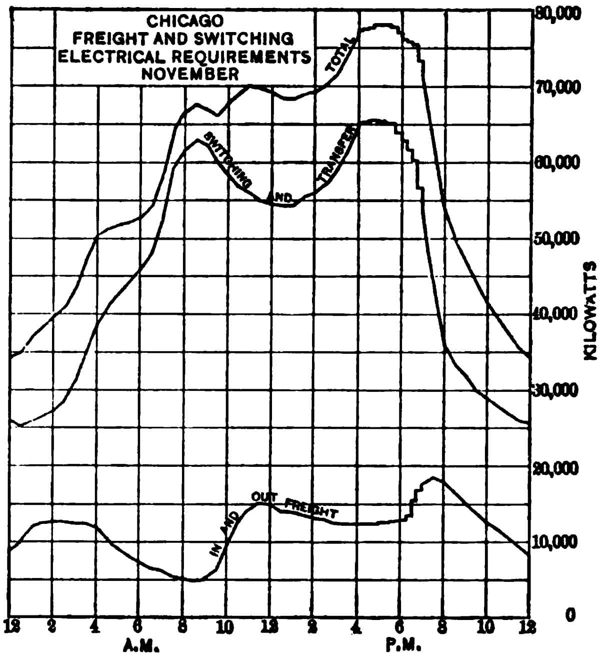


Fig. 19

would have a system for itself, and so on all the way down the line.

Fig. 18 shows the electrification of steam railroads, with unified power supply, in the city of Chicago. That is what it would be like if all the companies obtained their power from one source, and shows the difference between purchased power and individual production.

Fig. 19 is the load diagram of the freight electrical requirements of the steam railroads in Chicago. This is a curve we

have had worked out in relation to freight business, and it shows some rather interesting things. This freight curve has an extremely good load factor, estimated at 70 per cent daily and 60 per cent yearly. Through freights come in during the early morning hours and are broken up, switched and transferred from seven o'clock in the morning on, and then during the late afternoon there is another switching and transfer peak caused

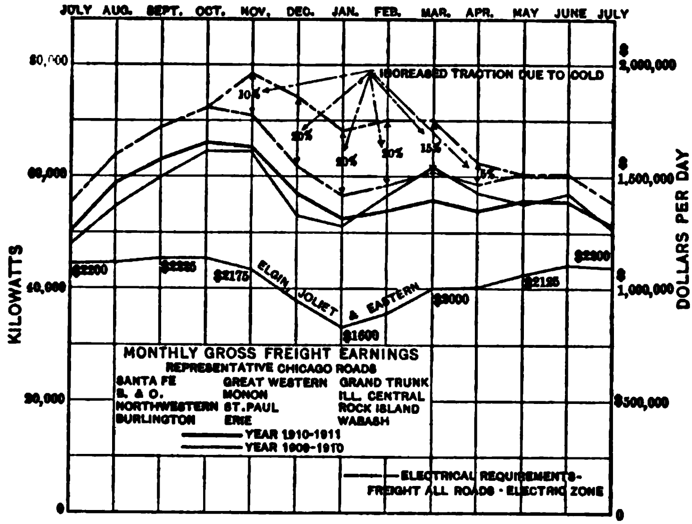


Fig. 20

by the making up of the through freights and getting them ready to go out as soon as the late-afternoon passenger peak is over. The peak on the in-and-out freight of the day occurs from seven o'clock in the evening on, due to these outgoing through freights which were made up in the late afternoon.

Fig. 20 is the diagram of the freight earnings and monthly freight electrical requirements of the roads in Chicago. It shows the monthly gross freight earnings for two years for a group of Chicago roads, and also for the Elgin, Joliet & Eastern, which latter ought to show whether local Chicago conditions vary materially from the curve for the trunk lines included, as

it has been impossible to get, in any way, the figures of local earnings of the different trunk railroads.

It has been assumed that normal electrical requirements of freight traffic will vary for the different months of the year similarly to the variation shown for the twelve roads for 1910

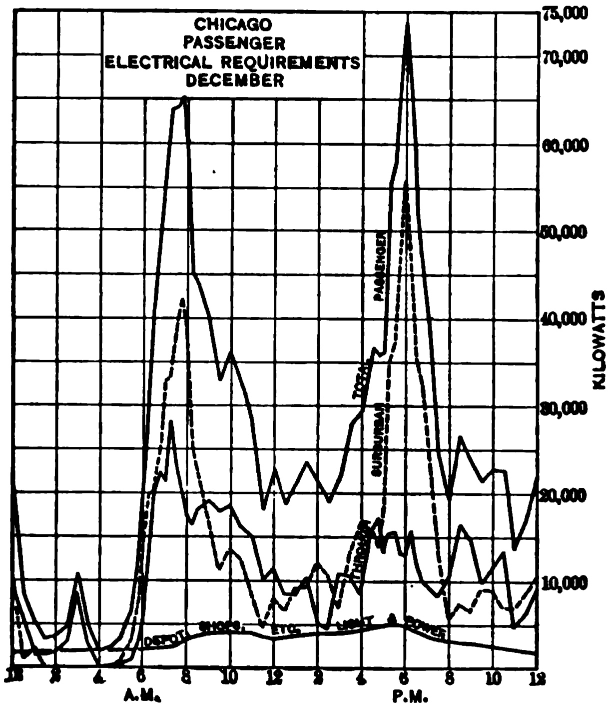


Fig. 21

and 1911 and that these normal requirements will be increased during the winter months as shown, on account of increased traction or increased resistance due to the cold.

Fig. 21 is the load diagram of the steam-railroad passenger electrical requirements in Chicago. This diagram shows these requirements in December. It has the same general characteristics as the New York curve, with the high peak morning

and evening, owing to the suburban passenger business and owing to the heating of the cars.

Fig. 22 shows the passenger earnings and monthly electrical

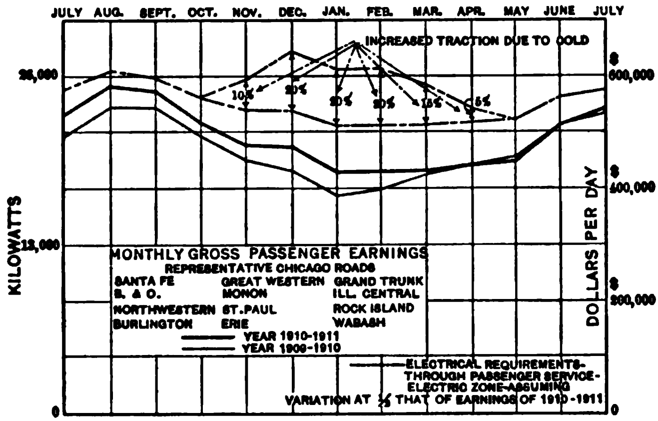


Fig. 22

requirements in Chicago, the latter being based on an assumed variation one-half that of the earnings for 1910–11. This diagram assumes, for through passenger business, that the cars will be heated by steam, and you will notice the increased energy which is required for traction owing to the cold.

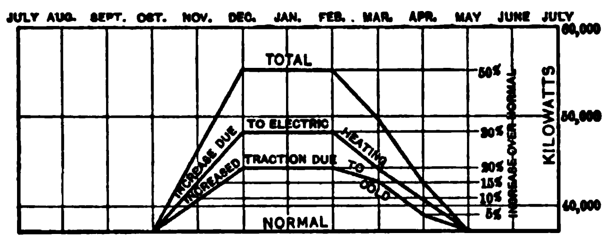


Fig. 23. Electrical Requirements for Suburban Railroad Service in Proposed Chicago Electric Zone

Fig. 23 shows the proposed steam-railroad suburban electrical requirements, month by month, in Chicago. In addition to the normal amount of energy required, there is the increased

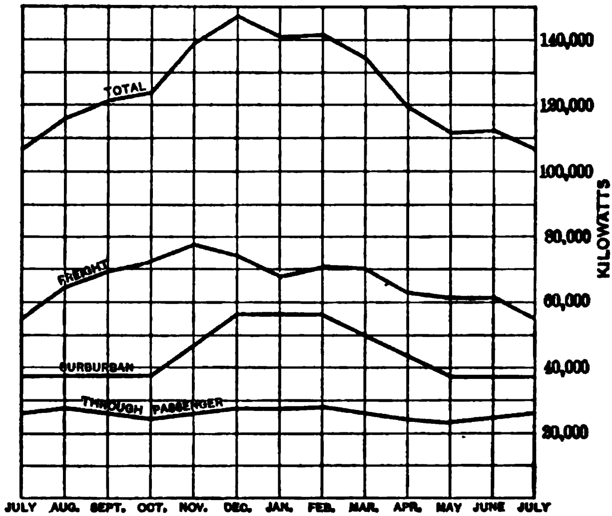


Fig. 24. Monthly Variation in Maximum Electrical Requirements in Proposed Chicago Electric Zone for Railroads

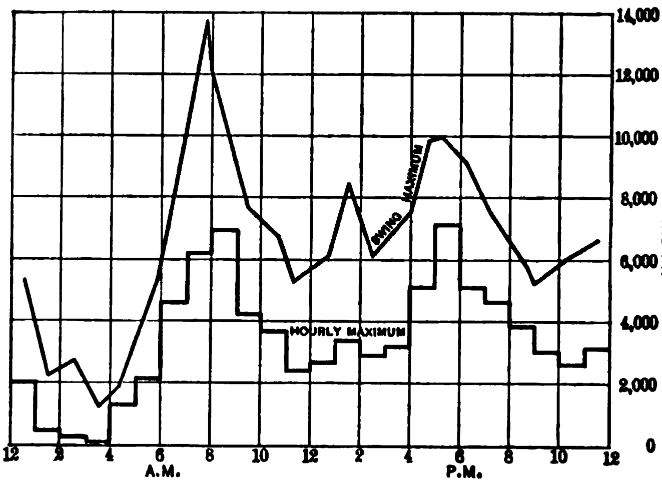


Fig. 25. Relation of Swing Maximum to One-Hour Maximum.—New York, New Haven and Hartford Railroad, Cos Cob Station, July 17, 1911

requirement for traction due to cold, and the increase due to electric heating.

Fig. 24 shows the monthly variation in the total electrical requirements in the proposed electrification of the Chicago steam railroads. You will remember that the load factor of the through passenger business is extremely good, and of the freight business extremely good. That would indicate, except in the ten or twelve large cities to which I have referred, that the freight and passenger business ought to be very good throughout the country.

Fig. 25 gives a comparison between the swing maximum and the one-hour maximum load on the New York, New Haven & Hartford Railroad Company's Cos Cob station. This diagram of the New Haven road is important because it shows that small roads installing their own plants must provide machinery sufficient to cover the maximum swing, which frequently lasts several minutes, and which, in the case of the New Haven road, apparently necessitates a reserve amounting to 74 per cent.

The three-phase rating of their generators is 21,000 kw. and their maximum load is 9,050 kw., which is a reserve of 132 per cent. But their single-phase operation really reduces the actual capacity of the generators, on a single-phase basis, to 15,000 kw., which is equivalent to 74 per cent reserve. They apparently have no greater reserve than is necessary, because they are installing three 6,000-kw. three-phase units to take care of additional electrification.

In another part of the paper, for the purpose of figuring the rating of the steam plants if each of the roads installed its own plant, instead of using this actual 74 per cent reserve, we have assumed 50 per cent, to be conservative, as compared with 25 per cent reserve in case of purchase of energy.

The point brought out in this curve is also important from an operating point of view, because, with a system of central stations for all energy used in a community, the entire load factor would be in the neighborhood of 60 per cent, as shown in Table I, compared with 25 per cent for this diagram using the maximum swing.

Possible Saving by Concentration of Production and Primary Distribution

I would like to say just a little, before I conclude, with relation to the actual saving that, in my judgment, could be obtained, assuming that an effort were made to bring about the concentration of production and the concentration of primary-distribution system in the area of Greater New York; that is, an area including the Jersey shore a little beyond the Hackensack River. The total saving in investment that could be worked out over a period of relatively few years, based on the experience that we have had in Chicago, would amount to about $18,000,000 to $20,000,000. That is in investment alone. The saving in operating expenses would amount to about $1,000,000 a year. Now, figuring fixed charges of 5 per cent for depreciation and 5 per cent for interest on the saving in investment, and adding to that the saving in operating expense, you have a sum almost equal to $3,000,000. That sum, capitalized at 5 per cent, means a creation of $60,000,000 of value.

At the rate of progress now going on in the neighborhood of New York the business is bound to double inside of ten years. If the present scheme is followed out — if the traction companies have their own separate sources of supply; if the electric-light-and-power companies have their own separate sources of supply; if the steam railroads that are apparently on the threshold of electrification have their own sources of supply — at the end of ten years the waste in money which will have taken place, on a 5 per cent basis, will be somewhere between $140,000,000 and $175,000,000. The direct saving by a concentrated system of generation and primary distribution, leaving out of consideration altogether the saving in operating expenses, is of itself, in my opinion, sufficient to provide the necessary funds for that portion of steam-railroad electrification centering in New York. That is, assuming the steam-railroad requirements as about 170,000 kw. I do not believe that the portion of combined generating stations and

combined primary distribution system for that purpose would cost much over $100 to $110 a kilowatt, taking it on the basis of a combined system.

The figures which my engineers have prepared indicate that if there should be made a systematic effort at massing production and massing primary distribution in the area referred to, the amount of property that would be realized or made available for increased business would be worth $18,000,000, or thereabout. I do not think that the energy necessary for the steam railroads centering in New York and the primary system necessary to take that energy to the railroads would cost over $18,000,000.

Now the savings are here at your feet. The engineering representatives of the interests that have these various public services in charge are most of them members of the Institute, and they can check up the figures. I will not attempt to burden the Institute records with the details, but they are at the disposal of anybody who wants to use them. I am speaking not from any theoretical point of view, but from my own knowledge and experience in developing the business which it is my pride to preside over. I know that the change that I have been able to work there, from barely earning dividends to putting the property in a strong, conservative position, has been the result of following the policy that I have laid down here, and I urge the people who are interested to try to follow it out around New York. It is a policy that is worthy of the greatest engineers and worthy of the thought of the greatest financiers in this country. It is a conservation of the truest order. If the same policy is carried out throughout the United States, the conservation of fuel will be something tremendous and the conservation of labor will be something tremendous. The letting loose of capital that can be used in other directions will stimulate business.

There is no greater problem in the industrial world today, no problem that presents greater opportunities for the engineers to achieve distinction, no problem that presents greater opportunities for the financier to achieve distinction and profit, than

the proper method of producing energy and distributing it in a given area; and involved in that question is the solution of the providing of money for that portion of the electrification of steam railroads that ends when the energy is put into the track.

Before concluding, I think it is but fair to my own staff that I should say that it would have been impossible for me to present this paper if it had not been for the loyal and valued assistance rendered me for three months in preparing data for this discussion, under the direction of Mr. Peter Junkersfeld, of the Commonwealth Edison Company, and the close personal work of Mr. Fowler, our chief statistician; Mr. Gear, our engineer of distribution, and Mr. Bird, one of the engineers of our contract department. The gentlemen whom I have mentioned have worked so hard on this matter, and given so much of their time to it, that it is only due to them that I should make this statement.

APPENDIX

ELECTRIC POWER REQUIREMENTS OF CHICAGO STEAM RAILROADS ELECTRIFIED—1911-1912

PREPARED BY PAUL BIRD, H. B. GEAR AND E. J. FOWLER

ELECTRICAL REQUIREMENTS OF FREIGHT SERVICE ON ELECTRIFIED STEAM RAILROADS IN CHICAGO DISTRICT—COMPUTATIONS MADE IN MARCH, 1912

The electrical requirements of the freight service of Chicago have been worked out for the same zone that is being considered by the Chicago Association of Commerce Committee on Smoke Abatement and Electrification of Railway Terminals.

The computations cover the year from July, 1911, to June, 1912, and it is assumed that the steam railroads in this district are electrified with no changes in the tracks and yards, and that freight is handled through the city in the same manner and following the same routes as it does today.

When the railroads are actually electrified there is no question but that great changes will be made in the freight terminals, and that a large part of the freight that now comes through the heart of the city will pass around and outside the city limits and possibly outside the electrified zone.

The results of the investigation are:

Month	Maximum demand	Kw-hr.	Load factor Per cent
July, 1911	55,200	28,814,400	70.3
August	63,800	33,303,600	69.6
September	68,700	34,624,800	70.3
October	71,200	37,636,200	70.2
November	78,000	39,312,000	70
December	74,200	38,732,400	70.3
January, 1912	68,200	35,600,400	70.3
February	70,200	32,853,600	69.7
March	70,000	36,540,000	70.3
April	62,500	31,500,000	70.1
May	60,400	31,528,800	70.2
June	60,300	30,391,000	70
		410,837,200	

The maximum demands and the consumption for December, the month during which the railway maximum demand would occur, are as follows:

DECEMBER FREIGHT REQUIREMENTS

Railroads	Maximum demand	Kw-hr.
Wabash R. R.	1611	840,900
C. I. & L. R. R. (Monon)	736	384,200
L. S. & M. S. Ry	3244	1,693,400
N. Y. C. & St. L. R. R. (Nickel Plate)	1033	539,200
P. Ft. W. & C. Ry	3352	1,749,700
B. & O. R. R	1713	894,200
M. C. R. R.	2878	1,502,300
Erie R. R.	1680	877,000
P. C. C. & St. L. R. R.	2091	1,091,500
Chicago Great Western Ry	1124	586,700
Northwestern Ry	7605	3,969,800
Rock Island Ry	2520	1,315,400
C. B. & Q. R. R	5098	2,661,200
St. Paul R. R.	4127	2,154,300
Ill. Central R. R	4377	2,284,800
Santa Fe R. R.	913	476,600
C. & A. Ry	1572	820,600
C. & E. I. R. R.	3193	1,666,700
Grand Trunk R. R	1201	626,900
Wisc. Central (M. S. P. & S. S. M.)	1256	655,600
C. & O. of Indiana	110	57,400
Chicago & Indiana Southern	148	77,300
Pere Marquette	368	192,100
Chicago & Western Indiana	967	504,800
B. & O.—C. T. R. R	2390	1,247,600
C. Junction R. R.	4682	2,444,000
E. J. & E. Ry. (C. L. & S. E. R. R.)	3845	2,007,100
Belt Ry	7071	3,691,100
Chicago, West Pullman & Southern Ry	710	370,600
Ill. Northern	423	220,800
Manufacturers Junction	171	89,300
Misc. Belt Roads	1991	1,039,300
Total	74,200	38,732,400

Methods and Data Used in Making Computations.—From the Chicago Association of Commerce committee, a list was obtained of the number of steam locomotives used within the Chicago city limits in October, 1911. This list, showing the number of locomotives and locomotive-hours in each class of service, was as follows:

Service	Number of locomotives	Working hours per day
Through freight	361	812
Switching	560	7223
Transfer	182	2378
Through passenger	336	801
Suburban passenger	200	1000

An estimate was made of the coal consumption per working hour of each class of freight locomotive, and from the coal burned in the city limits per day the necessary electrical requirements for the same service were computed.

OCTOBER, 1911—CITY LIMITS

	Through freight	Switching	Transfer	Total
Number of locomotives	361	560	182	1,103
Number of working hours per day	812	7,223	2,378	10,413
* Lb. of coal per locomotive per hour	2,000	600	1,350	.....
Tons of coal per day	812	2,196	1,602	4,610
Lb. of coal per hour	67,670	182,083	133,500	384,253
* Lb. of coal per hour per locomotive drawbar horse-power	10	12	10	......
* Efficiency (from drawbar to power house)	60%	60%	60%	......
Average electrical load in kw	8,675	19,072	16,473	44,220
* Watt-hours per ton-mile	31	120	56	......
Ton-miles per day	6,767,000	3,821,814	7,036,610	17,625,424

* Assumption.

The pounds of coal per locomotive per working hour were assumed as shown above after consulting with several Chicago railroad men. The tons of coal per day obtained in this way check very closely with similar figures published in the 1911 report of the Chicago Smoke Department, which figures were obtained directly from the railroad companies.

The pounds of coal per hour per drawbar horse-power was assumed after discussing the subject with a prominent engineer of one of the large trunk-line railroads. As a result of many actual tests he found that his road used about eight pounds of eastern coal per drawbar horse-power. Correcting this figure for the difference in the heat value of the coal, the above figures were obtained for Chicago.

The efficiency of 60 per cent between the locomotive drawbar and the electrical power house was also chosen after discussing the matter with the same engineer. This takes into account the losses in the line, the transformers, and in the motors and gears of the electric locomotive.

The "watt-hour-per-ton-mile" figures are in accordance with results obtained on several electrified roads.

Having thus obtained the average power-house load in kilowatts for the city limits and the month of October, 1911, the following steps were taken:

1. The average load of 44,220 kw. was apportioned among the various railroads operating in the city.

2. The results were increased, so as to apply to the Chicago Association of Commerce Electric Zone instead of the city limits.

3. A study was made of the movement of freight cars during the different hours of the day, and the different months of the year. The increased traction on account of cold weather was also considered. The daily, monthly and yearly load factors were thus obtained.

4. The maximum demand and consumption was then computed for each railroad and each month of the year.

5. The results were checked in various ways.

Apportionment of Total Average Load among the Railroads.—The total average load was found to be 44,220 kw. for October and within the city limits. This was divided amongst the different railroads in accordance with the coal consumed by their freight engines as given in the Smoke Department report of 1911.

Increase of Figures to Cover Association of Commerce Electric Zone.—A statement of the track mileage of all railroads for the city limits and for the zone, was obtained from the Association of Commerce committee. With this as a basis, and from a careful study of the map, the figures of average electrical load were increased to cover everything within the zone. The average increase in load was 22 per cent.

The following table gives the average load in kw. for October, for the area within the city limits and also for the area within the Electric Zone.

Load Factors, etc.—A daily load factor of 75 per cent was assumed for the entire freight business of the Chicago district. Mr. L. C. Fritch (now chief engineer of the Chicago Great Western R. R.) investigated the subject of electrification of the Chicago terminal of the Illinois Central R. R. in 1909. He, of course, had access to all the records of the railroad and his load curves for the freight service show a load factor of 75 per cent. The subject of the movement of freight cars through Chicago was also discussed with several railroad officials connected with roads which are among the largest handlers of freight in the city, and from the information thus obtained, it seems certain that this figure is about right.

Average load in kilowatts, October, 1911, 54,000.

Maximum kilowatts, October, 1911 (75 per cent load factor), 72,100.

FREIGHT SERVICE

AVERAGE LOAD IN KILOWATTS, OCTOBER, 1911

Railroad	City limits	Per cent increase	Electric Zone	Maximum kilowatts 75 per cent load factor
Wabash R. R.	980	20	1180	1570
C. I. & L. R. R.	460	15	530	710
L. S. & M. S. Ry.	1890	25	2370	3150
N. Y. C. & St. L. R. R.	620	20	760	1010
P. Ft. W. & C. Ry.	1950	25	2403	3250
B. & O. R. R.	830	50	1240	1660
M. C. R. R.	1740	20	2080	2790
Erie R. R.	1020	20	1220	1630
P. C. C. & St. L. R. R.	1320	15	1520	2030
C. Great Western Ry.	750	10	820	1090
Northwestern Ry.	4430	25	5550	7400
Rock Island Ry.	1530	20	1840	2450
C. B. & Q. R. R.	2970	25	3720	4950
St. Paul R. R.	2500	20	3000	4010
Ill. Central R. R.	2900	10	3180	4250
Santa Fe Ry.	580	15	670	890
C. & A. Ry.	1000	15	1150	1530
C. & E. I. R. R.	1940	20	2330	3100
Grand Trunk	700	25	870	1160
Wisc. Central	450	100	900	1200
C. & O. of Indiana	80	15	90	100
Chicago & Ind. Southern	100	15	110	140
Pere Marquette	230	15	260	350
Chi. & Western Ind.	640	10	700	930
B. & O.—C. T. R. R.	900	100	1800	2350
C. Junction	3400	0	3400	4550
E. J. & E. Ry.	1400	100	2800	3730
Belt Ry.	4900	5	5140	6870
Ch. W. Pullman & Southern	500	10	550	700
Ill. Northern	300	10	330	420
Mfg. Junction	100	25	120	160
Misc. Belt Roads	1100	25	1380	1940
Total	44,220		54,000	72,100

In order to get at the variation in the freight business throughout the year, the freight earnings of several of the principal railroads were plotted as shown in Fig. 20. The ratios obtained in this manner were used in getting the maximum kilowatts for each month of the year.

It was then decided to add to the maximum kilowatts of the winter months, the following percentages to take care of increased traction due to cold.

Month	Per cent added on account of cold
November	10
December	20
January	20
February	20
March	15
April	5

In getting at the monthly kilowatt-hours, the Sunday requirements were assumed to be one-half of week-day requirements and four Sundays were used per month.

The following table shows the maximum kilowatt, the kilowatt-hour, and load factors for each month in the year.

FREIGHT ELECTRICAL REQUIREMENTS—CHICAGO

	Per cent of average daily earnings for October	Maximum kilowatts				Kw-hr.	Load factors
		Normal requirements	Additional on account of cold		Total maximum		Per cent
			Per cent	Amount			
July, 1911	76.5	55,200	..	....	55,200	28,814,400	70.3
August	88.5	63,800	..	....	63,800	33,303,600	69.6
September	95.3	68,700	..	....	68,700	34,624,800	70.3
October	100	72,100	..	....	72,100	37,636,200	70.2
November	98.4	70,900	10	7,100	78,000	39,312,000	70
December	85.7	61,800	20	12,400	74,200	38,732,400	70.3
January, 1912	78.9	56,800	20	11,400	68,200	35,600,400	70.3
February	81.1	58,500	20	11,700	70,200	32,853,600	69.7
March	84.4	60,900	15	9,100	70,000	36,540,000	70.3
April	81.3	58,600	5	3,900	62,500	31,500,000	70.1
May	83.8	60,400	..	....	60,400	31,528,800	70.2
June	83.6	60,300	..	....	60,300	30,391,000	70
						410,837,200	

Average monthly load factor....... 70.1
Annual load factor................ 60.1

Normal maximum kilowatts assumed proportional to earnings.
Load factor for week day assumed at 75 per cent.
Sunday requirements ½ of week day, assuming four Sundays to month

Ratio of Passenger to Freight Loads.—

Total kw. hr. per year, passenger..............183,452,500 or 31 per cent
Total kw. hr. per year, freight..................410,837,200 or 69 per cent
Total kw. hr. per year, passenger and freight....594,289,700 or 100 per cent

The 1911 report of the Chicago Smoke Department gives the average daily coal used by railroad locomotives in city limits as follows:

Tons of coal per day, passenger.....................1163 or 21 per cent
Tons of coal per day, freight........................4438 or 79 per cent
Tons of coal per day, passenger and freight...........5601 or 100 per cent

This is a good check on the computations of the electrical energy required as to the proportion between passenger service and freight service, for it is to be expected that locomotives engaged in freight service operate less efficiently than passenger locomotives.

Saving of Coal due to Electric Traction.—The total electrical energy per year required by the electrified steam railroads of Chicago is:

Passenger service	183,452,500 kw-hr.
Freight	410,837,200 kw-hr.
Total	594,289,700 kw-hr.

At three lb. of coal per kw-hr. the total coal per year in the power houses would be 891,000 tons.

The 1911 report of the Chicago Smoke Department shows that the railroads burn in their steam locomotives about 1,850,000 tons of coal per year in the city limits. Increasing this figure by 22 per cent, it is seen that the railroads burn about 2,260,000 tons of coal per year in the electric zone. The ratio of the coal burned with electric operation to the coal burned with steam locomotives is 1 to 2.55.

Mr. W. S. Murray, electrical engineer [1912] of the New York, New Haven & Hartford R. R., in a paper presented at the 1911 convention of the A. I. E. E. said: "It has been demonstrated that the ratio between the coal burned for operating passenger trains by electric rather than by steam locomotives is 1 to 2. In the case of switching engines, this rate is much greater, a figure of 1 to 3 being conservative."

Tonnage of Freight Handled in Chicago.—It is surprising to find how little information there is available on this subject. The railroads do not keep their records so that the tons or carloads of freight handled in the Chicago district may be obtained. Apparently the only record of any sort that was ever kept of the freight movements was in 1902 and 1903 when a committee of Chicago railroad officials made a report on the interchange of freight between the different roads. This report was made with particular reference to the clearing yards of the Chicago Union Transfer Company. A copy of this report was borrowed from Mr. L. C. Fritch, and by means of it an estimate was made of the tonnage handled by the eighteen principal roads operating in Chicago. The figures given in this report cover the number of loaded and empty cars handled during the year ended June 30, 1903. To get at the tons of freight handled in the year ending June 30, 1912, the following assumptions were made:

Weight of empty freight car	18 tons
Weight of loaded freight car	40 tons
Days per year	330
Increase of freight business from 1903 to 1912	67 per cent

The last figure was obtained by plotting a curve of the total ton-mileage of freight handled per year in the United States from 1902 to 1910. This information was obtained from Mr. Slason Thompson's bureau of railway statistics. From the data given in the 1903 report it was also possible to approximate the number of switching movements, transfer movements and "in or out" or through freight movements.

After getting the number of tons of freight (including weights of cars) per day in each of these three classes of freight movement, by assuming the

average distance traveled in each class of movement, the ton-miles were obtained. The mileages assumed were:

Through freight	7 miles
Switching	2 miles
Transfer	10 miles

It may seem surprising that the average transfer haul is longer than the average in-or-out haul, but this is undoubtedly true. The list previously given shows 2,378 transfer locomotive-hours per day as against 812 through-freight locomotive-hours.

Knowing the average ton-miles per hour and applying figures for "watt-hours per ton-mile," the average electrical load was obtained. The table on the opposite page shows the results of these computations.

As the 1903 interchange report only covered the eighteen principal trunk-line railroads, the figures thus obtained serve only to check a part of the results arrived at by the other methods.

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Determination of Electric Power Required to Operate Passenger Trains at Chicago Terminals

General Plan.—Observations were made on a mid-week day between 4 and 5 p.m. as to the number and kind of cars making up each train entering and leaving each of the six passenger stations now in operation.

At the Northwestern station and the Grand Central station these observations were extended to include all trains entering and leaving the station throughout a twenty-four-hour period, these two being chosen as the ones representing the heaviest and lightest traffic, respectively.

From the data secured by observations average weights of trains for the different classes of service were derived, and from these weights and the special time schedules prepared by the railroads for the use of their employees, the running time and average kilowatt demand for each train were calculated for all through trains for the entire twenty-four hours. Twenty-four-hour load curves were plotted from average weights of trains for the suburban service of the Northwestern and LaSalle Street stations, these stations being taken as typical of the suburban service of other stations.

Through trains were considered as being operated by locomotives and suburban trains as being made up of multiple-unit cars similar to those used by the New York Central, with two trailers to three motor cars. From these train diagrams, load curves were derived for the rush hours from four to eight o'clock for the six terminal stations, the curve for through trains being determined separately from that of the suburban trains.

From the observations taken in the other stations between 4 and 8 p.m. suburban load curves were plotted for those hours and a total curve for subur-

FREIGHT ELECTRICAL REQUIREMENTS—EIGHTEEN TRUNK-LINE RAILROADS

	Through freight Ave. length of movement, 7 miles Watt-hours per ton-mile, 30			Switching Ave. length of movement, 2 miles Watt-hours per ton-mile, 120			Transfer Ave. length of movement, 10 miles Watt-hours per ton-mile, 60			Total ton-miles per day	Total average kw.
	Tons per day	Ton-miles per day	Kw. average	Tons per day	Ton-miles per day	Kw. average	Tons per day	Ton-miles per day	Kw. average		
Wabash R. R.	32,018	224,126	280	33,735	67,470	337	14,392	143,920	360	435,516	980
C. I. & L. R. R.	15,647	109,529	137	16,066	32,132	161	6,720	67,200	168	208,861	460
L. S. & M. S. Ry.	60,232	421,624	527	68,141	136,282	681	27,323	273,230	683	831,136	1890
N. Y. C. & St. L. R. R.	21,876	153,132	191	25,256	50,512	253	7,328	73,280	183	276,924	620
P. Ft. W. & C. Ry.	62,312	436,184	545	71,868	143,736	719	27,574	275,740	689	855,660	1950
P. C. C. & St. L. R. R.	43,474	304,318	380	47,602	95,204	476	18,779	187,790	469	587,312	1320
B. & O. R. R.	23,990	167,930	210	27,425	54,850	274	13,915	139,150	348	361,930	830
M. C. R. R.	62,144	435,008	544	66,402	132,804	664	21,507	215,070	538	782,882	1740
Erie R. R.	30,369	212,583	266	36,819	73,638	368	15,393	153,930	385	440,151	1020
C. Gt. Western Ry.	23,769	166,383	208	24,910	49,820	249	11,540	115,400	288	331,603	750
Northwestern Ry.	122,091	854,637	1068	187,258	374,516	1873	59,602	596,020	1490	1,825,173	4430
Rock Island Ry.	50,007	350,049	437	64,853	129,706	648	17,797	177,970	445	657,725	1530
C. B. & Q. R. R.	83,010	581,070	726	136,838	273,676	1368	35,054	350,540	876	1,205,286	2970
St. Paul R. R.	90,580	634,060	792	108,788	217,576	1088	24,992	249,920	625	1,101,556	2500
Ill. Central R. R.	90,814	635,698	794	109,328	218,656	1093	40,459	404,590	1011	1,258,944	2900
Santa Fe Ry.	19,168	134,176	168	24,176	48,352	242	6,717	67,170	168	249,698	580
C. & A. Ry.	29,648	207,522	259	33,463	66,926	335	16,061	160,610	401	435,058	1000
C. & E. I. R. R.	61,460	430,220	538	62,779	125,558	628	30,898	308,980	772	864,758	1940
Total	922,607	6,458,249	8073	1,145,707	2,291,414	11,457	396,051	3,960,510	9896	12,710,173	29,420

ban trains made up for the hours of 4 to 8 p.m., thus fixing the maximum for the suburban service at all stations.

Having determined the ratio of the combined suburban curve of the Northwestern and LaSalle Street stations to the total suburban curve for the hours of 4 to 8 p.m., this ratio was applied to the Northwestern and LaSalle Street stations' suburban curve for the remainder of the twenty-four hours in order to get the total suburban load curve.

Twenty per cent was added to the through-train load to allow for increased traction due to cold weather and fifty per cent to suburban train load for

TOTAL LOAD CHICAGO THROUGH TRAINS

Time	Grand Central	N. W.	LaSalle	Union	Dearborn	I. C.	Total kw.
A. M. 12:00	...	....	1600	1470	2090	1340	6,500
12:30	360	....	610	1470	340	1180	3,960
1:00	360	....	610	....	....	....	970
1:30	...	....	250	730	....	....	980
2:00	...	....	1180	....	....	....	1,180
2:30	...	....	1190	....	720	....	1,910
3:00	...	620	1400	1900	590	1490	6,000
3:30	...	...	....	580	....	1360	1,940
4:00	...	...	....	....	....	....	....
4:30	...	140	....	....	....	....	140
5:00	...	140	160	....	....	....	300
5:30	...	...	....	....	....	550	550
6:00	560	...	1750	990	....	550	3,850
6:30	560	1180	3940	4220	2860	1570	14,330
7:00	280	1760	1760	3540	2640	2710	15,310
7:30	530	2400	4650	3880	2710	2370	16,540
8:00	1270	1990	3280	3990	940	940	12,410
8:30	1130	3350	4450	2390	810	940	13,070
9:00	1140	3060	3100	3000	3100	390	13,790
9:30	...	2750	2620	3330	3300	1680	13,680
10:00	370	2810	1830	4220	750	3280	13,260
10:30	370	1320	3830	2410	1090	2590	11,610
11:00	...	3750	3170	1600	1270	1050	10,840
11:30	...	1050	1600	2200	1810	540	7,200
P. M. 12:00	310	1050	2280	2060	1950	580	8,230
12:30	580	720	1510	....	2710	570	6,090
1:00	960	560	1930	700	650	1280	6,080
1:30	...	2080	1940	1730	540	1200	7,490
2:00	...	200	1160	1900	540	....	3,800
2:30	...	850	2420	....	....	....	3,270
3:00	470	1250	1580	1670	1700	1120	7,790
3:30	...	1650	3000	1380	980	560	7,570
4:00	890	930	1240	1880	590	450	5,980
4:30	890	1890	2630	2520	1550	2070	11,550
5:00	730	750	3280	2230	1580	930	9,500
5:30	270	1040	4190	3530	1160	930	11,120
6:00	440	750	2530	2730	1300	1530	9,280
6:30	930	3080	630	2490	....	1530	8,660
7:00	320	2240	1340	....	920	1780	6,600
7:30	...	460	1300	1560	590	1860	5,770
8:00	...	1010	1660	2350	720	1820	7,560
8:30	...	3000	2510	3160	1370	1810	11,850
9:00	...	1480	3010	1480	2900	1710	10,580
9:30	840	....	1860	590	2080	1630	7,000
10:00	870	610	940	2950	1140	1660	8,170
10:30	870	1800	1990	3410	870	580	9,520
11:00	...	1200	980	590	510	....	3,280
11:30	430	....	2310	....	1710	....	4,450
12:00	...	....	1600	1470	2090	1340	6,500

The above figures do not include the allowance for increased traction during winter months.

increased traction and electric light and heating. From these increased values the load curve for the winter months was made up.

The schedule of percentages of increase added during the fall and spring months for increased traction and heating which was used in connection with the freight power data, was applied to the passenger load curve for the purpose of determining the kilowatt-hour consumption for the different months of the year and the annual kilowatt-hour consumption.

Train Weights.—The weights of trains were calculated on the following basis:

Locomotives	110 tons
Baggage, express and combination cars	60 tons
Day coaches	40 tons
Ordinary Pullmans	62½ tons
Steel Pullmans	75 tons
Diners	56 tons
Trailer cars (suburban)	40 tons

Method of Calculation.—From the total weight of the train and the distance traveled in the zone the ton-miles were derived. For locomotive trains an energy consumption of 40 watt-hours per ton-mile was assumed; for the express run of suburban trains, 55 watt-hours per ton-mile, and for the local run of express and local trains, where stops are frequent, 120 watt-hours per ton-mile. From the kilowatt-hours used by the train and the elapsed time as figured from the time schedules, the average kilowatts required by the train during the time of its run was calculated.

From the kilowatt demand of the trains the load curve was made up by the use of a train diagram showing the number of trains and the power taken by them at each half-hour interval except during the peak hours when the calculations were made for each fifteen minutes.

Fig. 22 shows how the through passenger load would vary throughout the year, making proper allowances for increased traction due to cold weather, also taking into account the variation in the amount of business done. It is assumed that the amount of energy required for the different months, exclusive of traction due to cold, would differ from January by a percentage equal to one-half the per cent difference between the earnings for January and the other months of the year.

Fig. 23 shows the suburban requirements of the year. The normal requirements are assumed as constant, and the additional due to increased traction and heat are shown.

Summary Electrical Requirements for Passenger Service

Normal Requirements.—The suburban service is assumed the same as January throughout the year. Sundays, for the suburban service, are assumed to have 33⅓ per cent of week-day requirements.

REQUIREMENTS OVER NORMAL

	Suburban and Through. Increased traction on account of cold.	Suburban Only. Heat
November	10 per cent	15 per cent
December	20 per cent	30 per cent
January	20 per cent	30 per cent
February	20 per cent	30 per cent
March	15 per cent	20 per cent
April	5 per cent	10 per cent

	Daily earnings over January expressed in per cent	Coincident maximum kilowatts			
		Through	Suburban	Light and power for depots, offices, shops, etc.	Grand total
July, 1911	12.6	11,490	37,310	3550	52,350
August	18.8	12,120	37,310	3550	52,980
September	17.6	12,000	37,310	4000	53,310
October	10.4	11,260	37,310	4250	52,820
November	5.9	11,880	46,640	4570	63,090
December	5.7	12,940	55,960	4850	73,750
January, 1912	....	12,240	55,960	4850	73,750
February	0.2	12,260	55,960	4570	72,790
March	0.3	11,760	50,370	4250	66,380
April	1.7	10,890	42,910	4000	57,800
May	2.6	10,470	37,310	3550	51,330
June	10.3	11,250	37,310	3550	52.110

	Kilowatt-hours				Load factor
	Through	Suburban	Light and power per month	Grand	
July, 1911	6,633,600	5,679,200	1,850,200	14,163,000	36.4%
August	7,045,700	5,816,700	1,882,700	14,745,100	37.4%
September	6,743,500	5,611,400	1,836,500	14,191,400	36.9%
October	6,504,000	5,679,200	1,895,000	14,078,200	35.8%
November	6,680,000	7,014,300	1,895,000	15,589,300	34.3%
December	7,472,500	8,518,800	2,068,000	18,059,300	32.8%
January, 1912	7,116,800	8,725,100	2,104,200	17,946,100	32.9%
February	6,658,700	8,109,200	1,816,600	16,584,500	32.7%
March	6,795,500	7,666,900	1,895,000	16,357,400	33.1%
April	6,123,400	6,453,100	1,836,500	14,413,000	34.6%
May	6,085,000	5,816,700	1,882,700	13,784,400	36 %
June	6,281,700	5,473,800	1,785,300	13,540,800	36.1%
Total	80,140,400	80,564,400	22,747,700	183,452,500	28.3%

Through-train requirements for different months were obtained by increasing the January figures by one-half the excess of the daily passenger earnings of those months. Sunday, for through trains, is taken as 80 per cent of a week-day.

The energy required for light and power for depots, offices, shops, etc., battery charging and operating switches is assumed at 5000 kw. maximum and 50 per cent annual load factor.

Calculation of Transmission and Conversion System for Passenger and Freight Loads

To determine the location and size of substations required for the supply of the third-rail system, the positions of all passenger trains which will be operating in the Electric Zone at 6:05 p.m., the time of the evening peak, were indicated upon a railroad map at Chicago, these positions being determined from the train schedules. No train schedules were available for freight trains, and it was therefore necessary to locate these on the map in amounts approximately equal to the demand of a single train, chiefly near the freight yards where switching is the heaviest, a few trains being located along the main line.

Two general plans of power supply were assumed, (a) based on the installation of a separate power system for each road or group of roads using the same tracks or operating under allied financial interests, and (b) based upon the entire power supply being operated as a unified system, the energy being derived from the nearest station of the Commonwealth Edison Company or the Public

Service Company of Northern Illinois, and all stations being used to supply all the roads which came within an economical radius thereof.

The position of substations was then fixed by allowing a distance of four to five miles apart on the larger roads and six miles apart on the smaller ones.

In scheme (a) where operation is contemplated by groups, power houses were located at points where condensing water was available where it was possible to secure such sites within a reasonable distance of the railroad company's tracks.

However, in the smaller system where the loads were from 5,000 to 10,000 kw. this was not entirely feasible, and sites were selected in some cases with reference to the distribution of the load.

In selecting the rating for generating stations under group operation, it was considered that from 50 per cent to 75 per cent surplus would be required to take care of swings in the load and provide suitable reserve.

Fig. 25 shows swings of nearly 100 per cent over one-hour maximum for New York, New Haven & Hartford Cos Cob station.

Transmission lines were laid out on a basis of a line for each 3000 kw. of load with a reserve line for each substation. The reserve supply was secured in the smaller substations by using one line with taps to two or three substations.

In the plan for unified power supply it was assumed that the present 600-volt substations of the surface and elevated roads would be available, when increased in size, as sources of 600-volt supply for all roads coming within an economical range of their distribution, and the necessary number of additional lines to these substations to supply the steam-railroad load is included in the estimates.

It is assumed that transmission lines would be run overhead along the railroad company's right-of-way in the outlying portions of the city where steel-pole construction of a substantial character could be employed. Wherever lines were run on public streets it was assumed that they would be carried underground.

Summary of Results

Under a unified plan of power supply, only 21 additional substations would have to be established, and the total number would be only 43 as compared with 72 substations under group operation.

The number of transmission lines under the unified plan would be 81 as compared with 132 under group operation, and there would be over 2.5 times the length of line required for group operation as compared with the unified plan.

The data for the unified plan are as follows:

Number of substations	43
Number of lines	81
Rating of substations, kw	205,000
Rating of generating stations, kw	142,000
Length of lines, feet	1,390,000

The data for group operation appear in the table on the next page.

A comparison of the investment necessary for unified power supply, as compared with a separate supply for each road or group of roads, shows the following saving in favor of unified power supply:

Power-house rating	99,500 kw.
Substation rating	39,500 kw.
Transmission-line cables in feet	2,283,000 kw.

In addition to this saving, there is a corresponding saving in conduit construction, where the lines are underground, and in pole-line construction, where the lines are overhead.

DATA FOR GROUP OPERATION OF CHICAGO RAILROADS (ELECTRIFIED)

Railroads	Kilowatts			Rating in kilowatts		No. of substations	No. of Lines	Length of lines
	Freight load	Pass. load	Total load	Generating stations	Substations			
1. Ill. Cent.								
M. C. Pass.	4,600	20,400	25,000	37,500	37,000	7	19	329,000 ft.
2. L. S. & M. S.								
M. C. R. R. Freight								
C. R. I. & P. Pass.	8,750	7,750	16,500	24,000	28,000	7	14	255,000 ft.
3. C. & N. W.	8,000	25,000	33,000	50,000	51,000	8	19	479,000 ft.
4. C. M. & St. P.	4,350	3,050	7,400	14,000	14,000	4	8	121,000 ft.
5. C. & Gt. W.								
Grand Trunk.								
B. & O. C. T.								
I. H. Belt	10,500	2,000	12,500	22,500	26,500	15	21	1,224,000 ft.
6. P. F. & W. & C.								
P. C. C. & St. L.	5,700	2,000	7,700	14,000	20,000	10	12	637,000 ft.
7. Erie								
C. I. & L.								
C. & W. I.								
Wabash.								
Belt	16,300	3,200	19,500	30,000	32,000	10	18	290,000 ft.
8. Santa Fe.								
Alton	2,600	2,000	4,600	9,000	6,000	2	4	29,000 ft.
9. C. B. & Q.	5,400	5,400	10,800	16,500	14,000	3	8	47,000 ft.
10. C. R. I. & P.	2,400	3,000	5,400	9,000	9,000	3	6	15,000 ft.
11. Chicago Junction	5,000	....	5,000	9,000	.....	..	...	....
12. E. J. & E.	4,100	....	4,100	6,000	7,000	3	3	237,000 ft.
Total	77,700	73,800	151,500	241,500	244,500	72	132	3,673,000 ft.

There is also a corresponding, and possibly even greater, saving in the 600-volt feeder, cable and conduit or pole lines.

It must also be borne in mind that where the stations and substations are of larger average size, the investment per kilowatt is less than where the same load is distributed over a larger number of stations and substations. This same principle applies to transmission and distribution cable and conduit, and pole lines.

Also the same principle applies, to fully as great an extent, to the operating and maintenance cost of stations, substations and lines.

SUMMARY

TOTAL ELECTRICAL REQUIREMENTS—ALL STEAM ROADS

	Load at time of monthly maximum demand		
	Freight	Passenger	Total
July, 1911	54,250	52,350	106,600
August	62,700	52,980	115,680
September	67,500	53,310	120,810
October	70,900	52,820	123,720
November	76,700	63,090	139,790
December	73,000	73,750	146,750
January, 1912	67,000	73,020	140,020
February	69,000	72,790	141,790
March	68,800	66,380	135,180
April	61,400	57,800	119,200
May	59,400	51,330	110,730
June	59,300	52,110	111,410

	Kilowatt-hours			Load factor
	Freight	Passenger	Total	
July, 1911	28,814,400	14,163,000	42,977,400	54.3%
August	33,303,600	14,745,100	48,048,700	55.8%
September	34,624,800	14,191,400	48,816,200	56.2%
October	37,636,200	14,078,200	51,714,400	56.4%
November	39,312,000	15,589,300	54,901,300	54.7%
December	38,732,400	18,059,300	56,791,700	52 %
January, 1912	35,600,400	17,946,100	53,546,500	51.5%
February	32,853,600	16,584,500	49,438,100	51.8%
March	36,540,000	16,357,400	52,897,400	52.5%
April	31,500,000	14,413,000	45,913,000	53.4%
May	31,528,800	13,784,400	45,313,200	55 %
June	30,391,000	13,540,800	43,931,800	55 %
Total	410,837,200	183,452,500	594,289,700	46.2%

DISCUSSION FOLLOWING THE ADDRESS ON "THE RELATION OF CENTRAL-STATION GENERATION TO RAILROAD ELECTRIFICATION"

AFTER Mr. Insull had made his address of April 5, 1912, before the American Institute of Electrical Engineers in New York, on "The Relation of Central-Station Generation to Railroad Electrification," as reprinted in the preceding chapter, an interesting discussion ensued. Some of the principal points brought out are given here[1] in brief.

JOHN W. LIEB, JR., of the New York Edison Company, the first speaker to follow Mr. Insull, said, in effect, that the Institute had had too few fundamental papers of this character. He said that he believed the economic possibilities of the situation would have an important bearing on the engineering questions of varying frequencies and systems. He believed that every member was under deep obligation to Mr. Insull for his important address.

DUGALD C. JACKSON, professor in Massachusetts Institute of Technology, Boston, declared that a presentation of this kind must go far toward bringing economic views and engineering views into harmony.

WILLIAM S. MURRAY, then electrical engineer of the New York, New Haven and Hartford Railroad, said that, speaking as a railroad man, he regarded the paper as "a new light — almost a light in the darkness."

CHARLES P. STEINMETZ, consulting engineer for the General Electric Company, Schenectady, N. Y., said that the paper

1. The discussion is given in greater detail in the Transactions of the American Institute of Electrical Engineers, Part I of Vol. XXXI, p. 283 et seq.

announces the approach of a new era in the electrical industry. Dr. Steinmetz also made the point that concentration of electrical production and primary distribution permits the utilization of a diversity factor in engineering talent. No small system or utility employing electricity can hope to employ the high grade of engineering advice obtainable by the great electricity-supply system.

Lewis B. Stillwell, consulting engineer, New York, made the comment that the advantages that accrue from the utilization of the diversity factor decrease rather rapidly as the size of the individual aggregated plants increases. The speaker noted the fact that within eight years the improvement in prime movers had been such that a saving in coal amounting to about 30 per cent had been brought about. That is a factor that assists materially in carrying out the general idea of centralization.

C. A. Coffin, president of the General Electric Company, Schenectady, N. Y., paid a brief tribute to the work of men like Mr. Insull, Mr. Sprague and others.

Benjamin F. Wood, of the Pennsylvania Railroad, Altoona, Pa., said that the generating station and other electrical equipment of his company at the New York terminal represented an expenditure of about $8,000,000. Half of this would have been saved if electrical energy had been purchased. Further, if the energy could have been purchased at the rates prevailing in Chicago, the company could have paid a dividend of about 6 per cent on the other $4,000,000. "We are not the guilty one," declared Mr. Wood.

Cary T. Hutchinson, consulting engineer, New York, discussed the cost of producing electrical energy in Chicago. He had a colloquy with Mr. Insull on the subject. Dr. Hutchinson said in conclusion that the whole point, in spite of the saving in cost of production, was the price to the user.

Bion J. Arnold, consulting engineer, Chicago, after mentioning the fact that the Commonwealth Edison Company possessed one of the most economical plants in the world for the production of electrical energy, dwelt on the large and well

managed plant's ability to discard obsolete machinery, being able to stand the obsolescence loss. The speaker also discussed the thermal efficiency of generating stations, and said that after 10,000-kilowatt units have been reached the thermal efficiency remains nearly constant. Referring to the New York Central Railroad's generating stations near New York, designed eight or nine years before, Mr. Arnold made the point that what might be regarded as errors now in relation to the economics of electricity supply were not errors then. Mr. Arnold expressed himself as in sympathy with Mr. Insull's policies.

FRANK J. SPRAGUE, consulting engineer, New York, alluded to the very great importance of increasing the efficiency of power production. He looks forward to the time when a comparatively few great central stations will replace the thousands of small plants of today. He mentioned the waste of water in a large city like New York, due to the number of small non-condensing steam-engine plants. He extended his personal thanks to Mr. Insull for an epoch-making paper.

OPPOSITION TO ECONOMIC WASTE

MR. INSULL (after discussing with Mr. Stillwell a tentative question of long-distance power supply and closing the discussion): I did not come down here to discuss the cost and selling price of the Commonwealth Edison Company's commodity. I am not here to sell my own goods. I do not need to make any answer as to whether my prices are high or low, except to take the exact statement made by Mr. Wood as to what would have been the advantage to the Pennsylvania Railroad if it had purchased energy on the same basis on which I am selling it in Chicago. If you will refer to some of your older records you will find, also, that Mr. Wood made practically the same statement with reference to the West Jersey and Seashore Railroad.

I was dealing with the matter on a broad basis. Probably outside of the very large traction companies in Chicago, I am one of the largest purchasers of energy in this country. In other words, I take a dose of my own medicine.

Of course, in dealing with the situation I have naturally had to refer to New York. It is the subject uppermost in the minds of you people. So, of course, I took New York as the basis of my figuring and compared it with the results we have obtained in Chicago. But it matters not to me who is the owner of the generating plant and the primary transmission system. I do not care whether it is the local lighting company, whether it is the local railway company, or whether it is the steam-railroad company; the principle is the thing I am contending for. I am contending against economic waste. When I speak of "purchased power" I simply use that term because it has come to be used in the industry as designating a difference between making your own power and buying it from some one else. I say again that I think it would be a great misfortune if, as the result of this meeting, or as the result of the agitation that is going on throughout the industry on this subject, some move is not made with reference to the concentration of the manufacture and primary distribution of electricity. I think one is almost as important as the other.

Limits of Economical Production not Reached

There are some other serious questions of an engineering character to be decided within the next year or two on this subject. I do not know at this time what the limit of size of unit is that will show the greatest efficiency. I have consulted the best experts I can find on both sides of the ocean. The question of size of unit comes in very much in this question of concentration of production of energy. I do not think we have by any means reached the economical limits of the cost of production. I do not think it is possible for any ordinary public-service company, by itself, doing just purely its own business, to take advantage of the economical limit when we reach it. I think it can only be done by an aggregation of companies.

There are a good many things we can learn to advantage from our neighbors. I have been for a good many years in the habit of sending my engineers to Europe to see what they

can find out. We find that we get full value for the expense of the trips. I do not know of any case on the other side where steam-railroad electrification on any considerable scale has been started and the railroad companies have built their own generating stations. They go a great deal deeper into the economies of things than we do in this country. We make money easier here; we have greater markets. We can take a lesson from their experience.

I make one suggestion to the Railway Committee of the Institute. Take the remarkable situation you have here on the Atlantic seaboard, with great density of population in the small amount of territory between Philadelphia and Boston. Take Philadelphia, New York and Boston, nuclei of areas stretching out as three fans; take places like the Connecticut manufacturing towns; go along the Boston and Albany Railroad to Albany, and then cross New Jersey, through Pennsylvania to the south of Philadelphia. Figure out the money that can be saved by putting all the generation of electricity in that territory under one ownership. I do not care who owns the generating plant, whether it is the railroad company or the lighting company or the traction company; but I venture to say that the amount of money you would save would not only be sufficient to build the transmission lines and the generating stations of steam railroads in that territory, but I think it would go a long way toward equipping the railroads themselves.

Discussion at Boston on June 26 and 27, 1912[1]

Frank J. Sprague explained how Mr. Insull's address to the Institute came to be made. He told something about the electrification agitation in Chicago and advocated the creation of an independent financial organization to stand between the electrical manufacturing companies and the railroad companies in electrification enterprises.

H. G. Stott, superintendent of motive power of Inter-

1. At the suggestion of Mr. Sprague, discussion of Mr. Insull's paper was resumed at the annual convention of the Institute.

borough Rapid Transit Company, New York, contended that Mr. Insull's results in Chicago were obtained not by combining first-class plants but by combining in one or two plants the output from a number of practically broken-down plants — plants ripe for reconstruction. Mr. Stott took issue with Mr. Insull on the question of concentrating production of large, modern plants. He thought that an ideal solution would be for each company to retain its own plant, thereby preserving its equity, with an agreement by which each plant should supply all power within its own zone of economical distribution.

WILLIAM MCCLELLAN, New York, thought that there should be no jumping at conclusions in the matter of utilizing the diversity factor in proposed railroad electrifications.

PERCY H. THOMAS, consulting engineer, New York, pointed out that the trend has been toward centralization since the electrical industry came into being.

W. G. CARLTON, superintendent of power, electrical division, New York Central Railroad, New York, suggested the possibility of "pooling" generating stations.

CALVERT TOWNLEY, Westinghouse Electric and Manufacturing Company, New York, said that he realized the benefits of concentration, but realized also that the principle had limitations.

W. S. LEE, Southern Power Company, Charlotte, N. C., held that there should be large generating-plant units in different parts of the area so placed that each should carry approximately its own load, being at the same time interconnected with the others, so that one plant could help out another.

MR. SPRAGUE said that of course concentration should not be carried to an absurd or unsafe extreme, as, for instance, one generating station for a city like New York or Chicago.

WILLIAM S. MURRAY explained why the cost of generating energy in the Cos Cob station of the New York, New Haven and Hartford Railroad was comparatively high at that time.

WILLIAM B. JACKSON, consulting engineer, Chicago, drew attention to the fact that the electrification of railroads is only one factor entering into the discussion of Mr. Insull's subject.

No one could take exception to the principle of the paper. The possibilities of unified generation and transmission of electrical energy are very great.

Lee H. Parker, Stone & Webster Engineering Corporation, Boston, said that he did not see any reason why the comparatively small amount of energy required for the proposed electrified railroads in and near Boston should not be supplied by any one of the large energy-generating companies in existence in Boston.

C. O. Mailloux, consulting engineer, New York, remarked that, from one point of view, it might be well for both the specialist in the production of electrical energy and the specialist in transportation to stick to his specialty. But circumstances may alter cases. Financially, it may be important in launching, say, a traction project if the capital required for the generating plant can be omitted from the total investment. Even if the man interested in the project could raise the capital, it might be an advantage or a convenience not to do so. Referring specifically to the paper, Mr. Mailloux declared that it is a great advantage to have the possibility of studying the modern conditions of the supply of electrical energy without being compelled to go into that business.

P. W. Sothman, New York, gave it as his opinion that railway and commercial loads might well be combined. Each case must be studied on its merits, however.

C. L. de Muralt, New York, among other things, said: "I can easily conceive of his [Mr. Insull's] having in mind the supplying of all of the United States from one single network of lines, controlled by one company, which owns all sorts of power stations in the most convenient places — steam, hydraulic, etc.— and I do not doubt for one moment that the country would benefit by such a combination, provided it could be properly regulated."

N. W. Storer, general engineer of railway department of Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., gave this opinion: "If there were no fears on the part of power users that they were putting their business in

jeopardy by permitting all power to be concentrated by one company, there is not a particle of doubt in my mind that concentration would be made in the near future. * * * The ideal system which Mr. Insull advocates can be put into effect only when the power companies are put under the control, and the prices are subject to the regulation, of an honest and efficient government."

Edward N. Lake, Stone & Webster Engineering Corporation, asserted that the Boston Elevated Railway Company had no reason to question its wisdom in building its own generating station, in view of the rate understood to have been offered by the Edison Company of Boston.

Mr. Sprague, in closing the Boston discussion, reviewed briefly some of the engineering methods evolved in heavy electric railroading. An effort should be made to get uniform reports from railroads which have been electrified. Electrical engineers should endeavor to get the facts, no matter what they are. As to the fundamental fact of the discussion, everybody is agreed that there should be consolidation of power houses sufficiently large and well equipped to insure reliability, safety and economy.

A QUARTER-CENTURY CENTRAL-STATION ANNIVERSARY CELEBRATION IN CHICAGO—1887-1912[1]

CELEBRATING tonight, as we do, our twenty-fifth birthday, it affords me particular pleasure to speak to you. I remember well the early days of the Chicago Edison Company, when, instead of being its chief executive, I was its chief manufacturer.[2] Having established among the directors of the company some of the closest friends it has ever been my privilege to have, and partly on the suggestion I made myself to my friends, the late Edward L. Brewster and Mr. Byron L. Smith,[3] I received an invitation in 1892 to become the president of the Chicago Edison Company. Thus I was afforded the best opportunity that I knew of in the United States to develop the business of the production and distribution of electrical energy.

I have not prepared any set speech for this evening. I have asked my assistants to prepare for me a number of pictures and

1. The twenty-fifth anniversary of the Chicago Edison Company and its successor, the Commonwealth Edison Company, was observed on April 29, 1912. The meeting was held in Orchestra Hall, Chicago, and there was a large audience. It was given under the auspices of the Commonwealth Edison Company Section of the National Electric Light Association, and the chairman of the section in that year, Mr. R. F. Schuchardt, turned the meeting over to Mr. L. A. Ferguson, then second vice-president of the Commonwealth Edison Company, who presided and introduced Mr. Insull. In doing so Mr. Ferguson remarked that in the twenty years of Mr. Insull's presidency the rating of the company's generating stations had increased from about 5,000 horsepower to about 400,000 horsepower. He also said that the companies of which Mr. Insull was the chief executive officer had a combined capital of $175,000,000. Mr. Insull's address on this occasion has been somewhat condensed from the original printing in *The Edison Round Table*.

2. See note to chapter on "Problems of the Edison Central-Station Companies in 1897," page 1.

3. Mr. Smith, long a director of the company and a member of the executive committee, died in 1914.

diagrams that will enable me to trace the birth and the development of the industry from its early days in 1881 up to the time that the Chicago Edison Company was formed in 1887; and then its further development in this city, with some comparisons with other cities during the last ten years.

The gentleman whose picture I present to you [by lantern slide] needs no introduction. He has always taken a great

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THEO. N. VAIL, PRESIDENT BELVIDERE BROOKS, GENERAL MANAGER

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fq 26 ny qz 48 Rush
Orange NJ Apr 26 1912

Samuel Insull
180 West Adams St Chicago

On the twenty fifth anniversary of starting the old Chicago Edison Co I greet the employees of Commonwealth Edison Co and congratulate you all on the abnormally progressive spirit and work that has lead to the wonderful degree of success you have attained in quarter of a century.

Thomas A Edison

545pm.

interest in the work that is going on in Chicago, and you will find a message from him suitable to this occasion.[1]

Some Landmarks and Relics

The view which is presented in Fig. 1 is one of the old laboratory buildings at Menlo Park. It is now 31 years and a little over — to be strictly correct, 31 years and four weeks — since it was my privilege to visit Menlo Park for the first time and to see in operation the first incandescent-lighting system established there experimentally. This proved the possibilities of a business that has grown from that small beginning in the course of three decades to a business that today employs upwards of a billion and a half of capital.

Shortly after the experimental station was started at Menlo Park, Mr. Edison moved into New York, and the offices of the Edison Electric Light Company were established at 65 Fifth Avenue. Fig. 2 shows the building, which was turned from a

1. The portrait of Edison is given as the frontispiece of this volume.

mansion into an office. Fig. 3 is of much interest, as it shows the first direct-connected dynamo to be used commercially, so far as I am aware. The machine was built for us at the Twelfth Street station in New York. The particular view is that of the Edison central station in Milan, Italy, which had a rating of about 8,000 lamps, a similar one having been established in New York which had a rating of about 18,000 lamps. The New York station was started in September, 1882.

In Fig. 4 is shown the old Edison Machine Works, the old Aetna Iron Works, in which John Roach, the great American shipbuilder, made his success as a manufacturer. About my first experience, when as a boy I came to this country in 1881, was on a March morning, when I went with Mr. Edison, with whom I was serving at that time, and listened to his negotiations with John Roach for the leasing of the building for the Edison Machine Works, which was afterward succeeded by the large establishment at Schenectady, now known as the Schenectady works of the General Electric Company.

Some of the early specimens of Edison incandescent lamps are depicted in Fig. 5. They are lamps that were made about 1881 and 1882. In looking over some of the old pamphlets descriptive of the apparatus of that period we find the system of incandescent electric lighting recommended for these reasons:

"Because it is safest.

"Because the lamp when burning can be broken into the finest shavings of any description without causing any fire.

"It is the cheapest because there is no loss through imperfect combustion or defective burners, as in the case of gas.

"And it is best because it is simple in its application, can be turned on and off at will, and does not require the use of matches."

Fig. 6 represents one of the early electric-lighting fixtures.

The old Edison dynamo, a type of machine that was made in the years 1881 and 1882, is shown in Fig. 7. It was thought to have enormous capacity. It was possible to get enough current out of a machine of that type to light, I think, sixty 16-candlepower lamps!

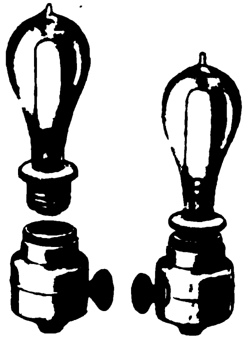


Fig. 5. Edison Incandescent Lamp of 1882

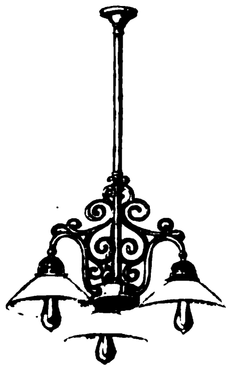


Fig. 6. Early Type of Fixture

Fig. 3. Early Edison Central Station in Milan, Italy

Fig. 4. Edison Machine Works in New York in 1881

Fig. 1. Edison Laboratory at Menlo Park in 1880

Fig. 2. Edison Headquarters at 65 Fifth Avenue, New York, in 1881

Fig. 7. Edison Dynamo of 1881 and 1882

Fig. 10. Edison Dynamo of about 1885

Fig. 9. Interior of Pearl Street Station, New York, of 1882, showing "Jumbo" Dynamos

Fig. 8. Exterior and Interior Views of the Appleton (Wisconsin) Central Station of 1882, the First in the World

The first Edison station, which was established in Appleton, Wisconsin, and originally had a rating of about 250 incandescent lamps, is illustrated in Fig. 8. This station was started April 20, 1882. Usually the New York (Pearl Street) Edison station is given credit as the first central-station distribution system and plant started in this country, but as a matter of fact, while the New York Edison Company station was designed and the construction of it started at an earlier date than the Appleton station, the latter should be given the credit of being the first commercial central station established anywhere in the world for the generation and distribution of electrical energy on a multiple-arc system. I do not believe that it is still in operation, it having been replaced by a more modern edifice and equipment.

An interior view of the first station in New York, known as the Pearl Street station, is found in Fig. 9. This plant was built in what was known as "The Swamp" district of New York. The boilers were down below and the dynamos and engines were carried above, being shown in the picture. The station naturally went out of existence years ago; but from an engineering point of view it will interest many of the engineers here as showing Mr. Edison's conception that what was necessary for central-station work was dynamo-electric machines directly connected to the shaft of the engine. The two engines shown ran at a speed of about 350 revolutions a minute, I believe.

Fig. 10 shows another type of bipolar Edison machine which was used in the early eighties. It represents the development of the small machine of Fig. 7 to a machine of a larger type. I believe that machine (Fig. 10) had the remarkable capacity of 250 16-candlepower lamps!

We come now to 1887. Fig. 11 gives a front view of the old Edison building, known then as 139 Adams Street, the same site that we now occupy as our offices.[1] In Fig. 12 is shown the

1. The building illustrated in Fig. 11 was remodeled about twenty years ago and is the present (1915) 120 West Adams Street. The "Edison Building" of today, one of the large office buildings of the city, is known as 72 West Adams Street.

engine room of the old Chicago Edison station. It was on the ground floor, or, rather, in a kind of half-basement. High-speed engines were belted to dynamos on the floor above. A view in the dynamo room is given in Fig. 13.

It was on August 6, 1888, that the Adams Street station was first operated on the system, and it was shut down permanently on August 19, 1894. The original equipment consisted of four 200-horsepower Armington & Sims engines, each driving two No. 32 Edison bipolar dynamos, with a rating of about 80 kilowatts each, or say somewhere around 600 to 800 horsepower. Some detail of the Edison switchboard in the Adams Street station is given in Fig. 14. It should be interesting to anyone connected with our switchboard department today.

Fig. 15 is that of the exterior of the Harrison Street station, Chicago. That station, in the early nineties, was probably one of the most celebrated stations for producing electrical energy in this country. The interior of the Harrison Street station is shown in Fig. 16. It is significant of the great growth of this industry that the entire rating of that station is less than the rating of one of the turbo-generator units that we order for our central stations in this present year. A view of our switchboard in the basement at Adams Street is given in Fig. 17. This switchboard is still in use.

Fig. 18 is a view of our Twenty-seventh Street station. After the establishment of the Adams Street station and before my connection with the company a small district was started down on the South Side and the energy produced locally at No. 2700 Wabash Avenue. At the present time this old station is used as a substation. Soon after I took charge of the property we built a station on North Clark Street by the side of the Newberry Library building (Fig. 19). These small stations give you an idea of the small things that we were satisfied with twenty years ago. Fig. 20 is a view of the interior of the North Clark Street station which was the first station that we built having vertical engines with direct-connected generators.

Particularly interesting is Fig. 21, which represents our

Fig. 11. Original Edison Building, Adams Street, Chicago

Fig. 14. Original Three-wire Switchboard in Adams Street Station, Chicago

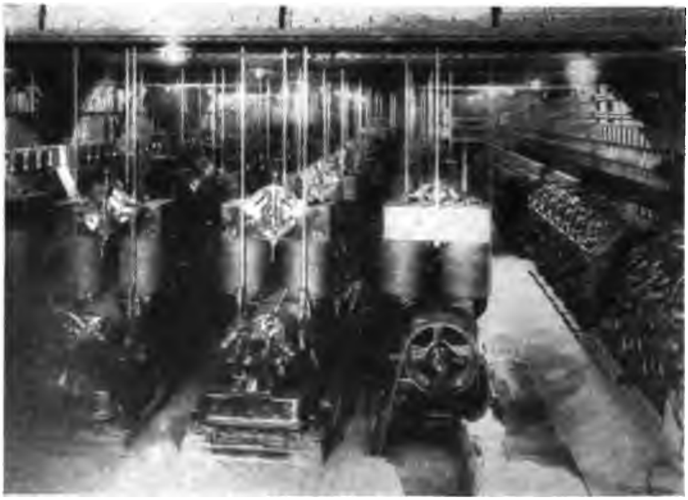


Fig. 13. Dynamo Room at Adams Street, Chicago, Station of 1888–1894

Fig. 12. Engine Room of Adams Street, Chicago, Station of 1888–1894

Fig. 15. Harrison Street Station, Chicago, Built in 1892

Fig. 16. Interior of Harrison Street Station, Chicago

Fig. 18. Twenty-seventh Street Station (now substation), Chicago

Fig. 19. North Clark Street Station (now substation). Chicago

Fig. 21. Rotary Converters of 1897

Fig. 17. Switchboard in Adams Street Station, Chicago

Fig. 20. Interior of North Clark Street Station, Chicago

first rotary converters. We put them into use at our Twenty-seventh Street station on October 15, 1897. These pieces of apparatus are of interest, not only to those connected with the Commonwealth Edison Company, but to the industry throughout this country and practically throughout the world, as I believe they represent one of the first attempts, if not the first, at massing the production of energy where it could be manufactured cheaply in large quantities, and its distribution made to distant points where the electricity could be converted to whatever pressure was necessary to enable it to be used in our service from house to house.

A view of our first storage battery, started in May, 1898, is presented in Fig. 22 (facing page 331).

Fig. 23 represents the growth of our business from 1888 to 1900. Each one of those lines across the sheet represents a year. You will notice that our progress was quite steady from year to year.

The original steam turbine and generator that we installed in the Fisk Street station is shown in Fig. 24. The Fisk Street station started operating on October 2, 1903. There are now ten turbines in Fisk Street station, each having a rating of 12,000 kilowatts, or, say, 18,000 horse-power, a total of 180,000 horse-power.[1] To give you an idea of the magnitude of power production in that station, I can tell you that four of those turbines would be about equal to the capacity of the steamships Lusitania or Mauretania.

Our Quarry Street station, opposite Fisk Street, has a rating of 84,000 kilowatts, or perhaps 120,000 horse-power.

An architect's drawing of our new Northwest Station (at North California Avenue and Roscoe Street) is reproduced in Fig. 25. When it was drawn it was assumed that we would have twin stations there. The plant we are building there now is at the left hand of the picture, and will have a rating of about 120,000 kilowatts. If we ever build the second station, the

1. Since the completion of the addition to Fisk Street station in 1914, the number of generating units in that station is twelve and the total rating in kilowatts is 165,000.

combined rating there will be about 240,000 kilowatts or, say, about 360,000 horse-power.

The diagrammatic drawing of Fig. 26 indicates the relative size of our generating units from the time of the starting of the

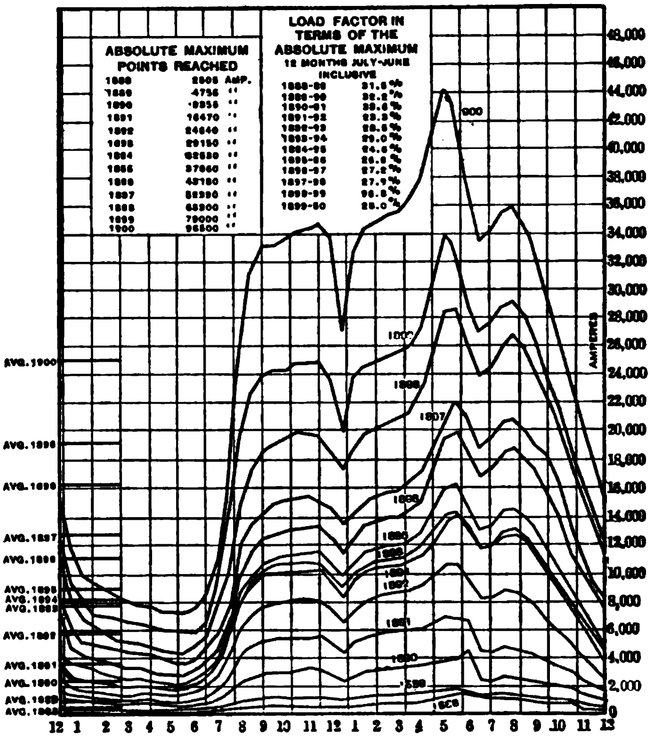


Fig. 23. Growth of Central-Station Business in Chicago (Composite Ampere Curves) from 1888 to 1900

Chicago Edison Company up to date. You see that the first one is about 160 kilowatts, the second one 3,500 kilowatts, and the third one 20,000 kilowatts.[1] The black columns indicate the relative rating of the units.

The curves in Fig. 27 give the yearly maximum kilowatt

1. Units of 25,000 and 30,000 kilowatts have been added to Fisk and Northwest stations since these words were spoken.

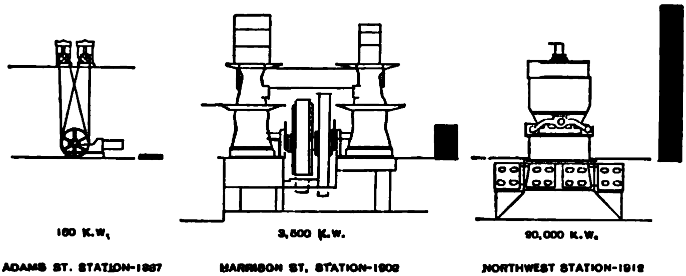


Fig. 26. Relative Size and Output of Generating Units in Chicago

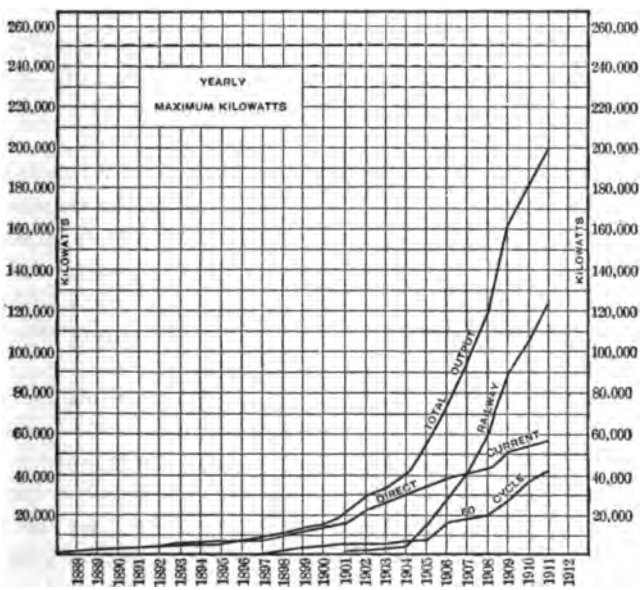


Fig. 27. Annual Maximum-Kilowatt Output in Chicago up to 1912

output of the company and show the growth over a period of years.

Statistical Data

Here are some decidedly technical curves — the annual load factors of the Commonwealth Edison Company.[1] The line marked "total" is practically the index of our ability to earn a greater or smaller amount of money on each dollar invested in our business. You will see where it starts in 1902 and goes gradually up until 1908, when it took a drop; but it is now higher than ever. Our load factor at the present time is between 40 and 50 per cent. In 1900 it was less than 30 per cent. That means that our investment is employed 50 per cent longer at the present time than it was employed in 1900. The result of that is that we can either earn more money on the dollar invested or else sell our product at a lower price to our customers. We take the middle course and try and earn a little more money on the dollar invested and sell our product at a much lower price to our customers.

Fig. 28 shows the total output of the company from about the latest date of Fig. 23 up to 1911, showing the remarkable growth, year by year, governed somewhat by general business conditions. I draw your attention especially to the growth from 1909 to 1910. General business began to drop off a little, so the growth between 1910 and 1911 has not been quite so great; still it has kept up at a pretty good rate.

Conservation of fuel is important. As our output has gone up and as we have been able to buy apparatus of a more economical character, our coal consumption has gone down. The saving in the consumption of coal per unit of output in the ten years from 1901 to 1911 is equivalent to a saving for the year 1911 of 1,504,000 tons, or 37,500 carloads of coal a year, or three trainloads of 37 cars each every day. The importance of that side of our business and the possibilities of what can

1. The reference here is to the diagram given as Fig. 9 of the chapter on "The Relation of Central-Station Generation to Railroad Electrification." See page 272.

probably be accomplished, as the use of electrical energy extends and the uneconomical consumption of fuel ceases, has

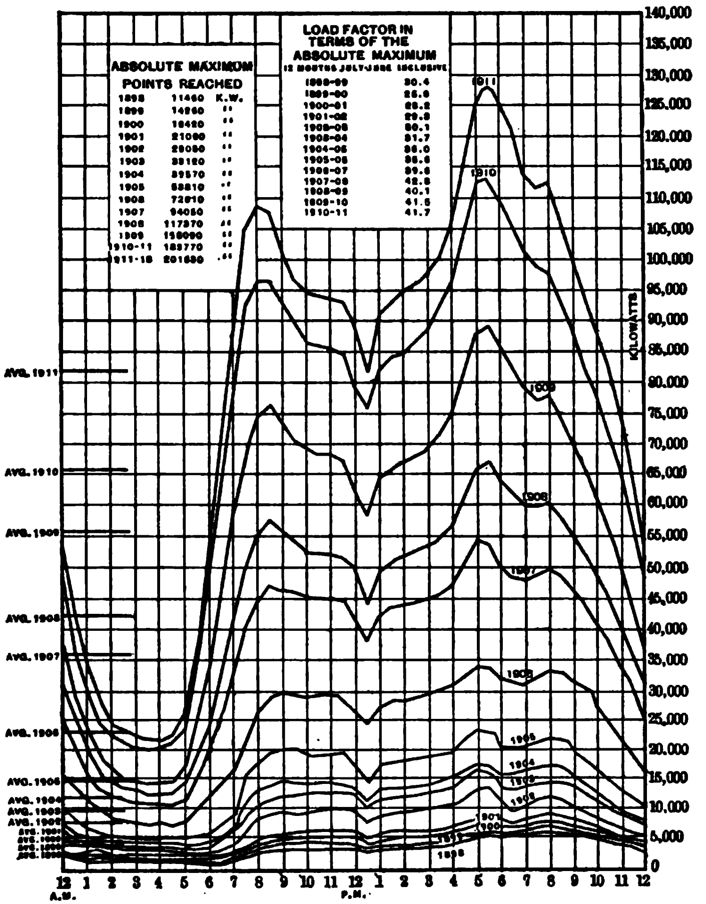


Fig. 28. Total-Output Curves (in Kilowatts) for Chicago, 1898–1911

been well shown in the addresses of Mr. de Ferranti, president of the (British) Institution of Electrical Engineers.

Fig. 29 shows the lighting rates per kilowatt-hour for one, two, three and four hours' use per day; also kilowatts connected.

In Fig. 30 is indicated the amount of light that one dollar will buy.[1] One dollar now buys almost nine times as much electric light as it did in 1886, and more than twice as much as it did in 1907, only five years ago. The cost of electricity for two hours' use a day has decreased 69 per cent. Fig. 31 illustrates an

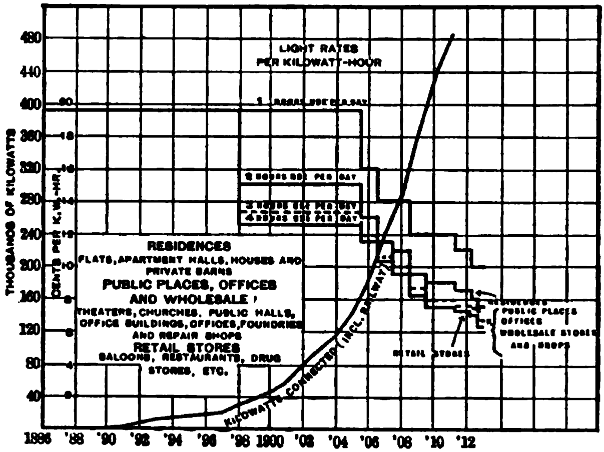


Fig. 29. Lighting Rates for Various Hours of Use Daily (Chicago, 1912)

electric-light bill in 1892 and one in 1912, a difference of twenty years. The 1892 bill was dated November 5, 1892, and amounts to $64.98 net, or an average of 19 cents per kilowatt-hour. The 1912 bill is based on the same kilowatt-hours but figured at our present rates, and amounts to $19.95 net or 5.8 cents per kilowatt-hour.

It is rather interesting to note the amount of money that we contribute for public purposes (Fig. 32). In 1889 we contributed $6,000; in 1899 we contributed $27,700, and in 1911 we contributed $1,057,500 to the city in the form of taxes and municipal compensation. This diagram (Fig. 33) gives the information with relation to fuel. In 1889 we spent $8,860 for fuel; in 1899 we spent $159,600, and in 1911 we spent $1,591,100.

1. The idea illustrated by the chart of Fig. 30 is set forth in a different manner by Fig. 4 of the chapter on "Electrical Securities," page 431.

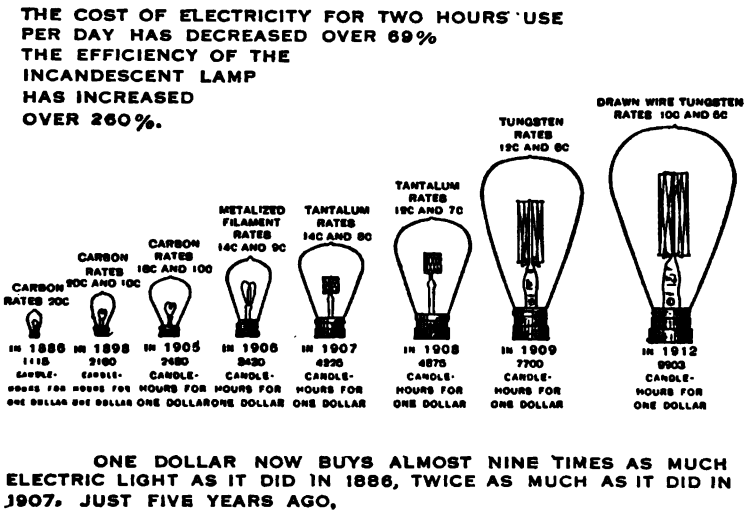


Fig. 30. A Chart of 1912, Showing Relative Amount of Electric Light One Dollar Would Buy

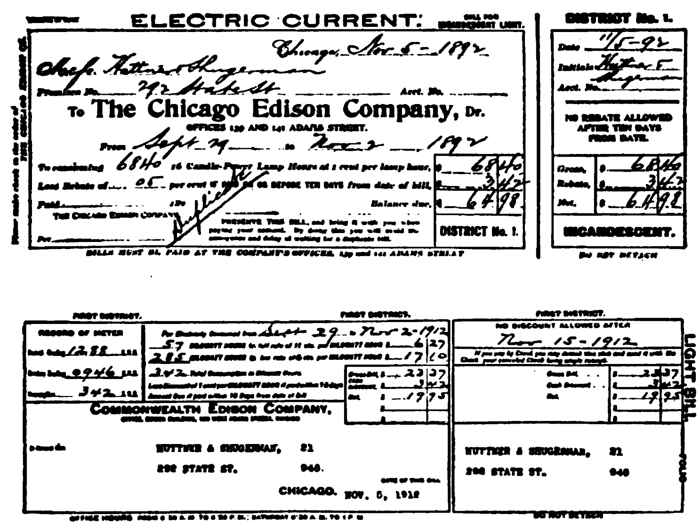


Fig. 31. Bills of 1892 and 1912 for the Same Amount of Energy, Showing Decrease in Price

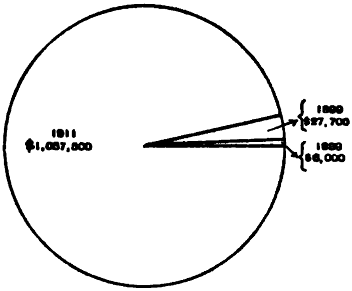


Fig. 32. Annual Payments for Taxes

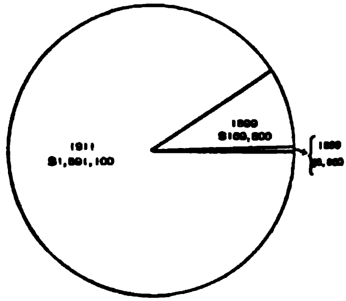


Fig. 33. Yearly Cost of Fuel

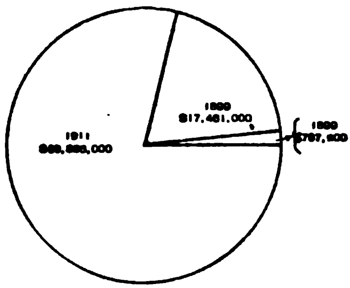


Fig. 34. Total Amount Invested in Plants

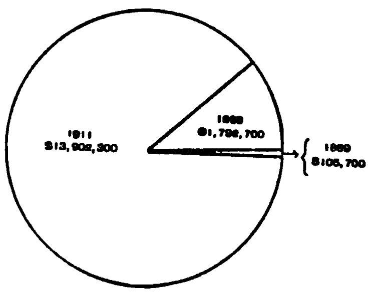


Fig. 35. Income from Sales of Electricity

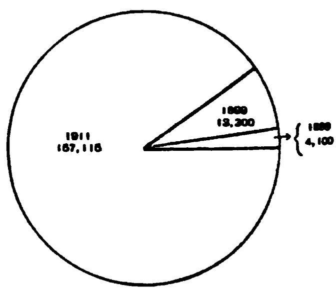


Fig. 36. Number of Customers

Graphical Representation of Chicago Central-Station Growth

Fig. 34 shows the striking increase in our investment. In 1889 we had $797,200 invested in plant. That means in generating stations and distribution system. In 1899 we had $17,461,000 invested, and in 1911 we had the imposing sum of $69,896,000 invested.

In 1889 our income from sales of electricity was $105,700; in 1899 $1,792,700, and in 1911 $13,902,300. (See Fig. 35.) In 1893, as shown in Fig. 36, we had 4,100 customers; in 1899 we had 13,300, and in 1911 we had 157,115.

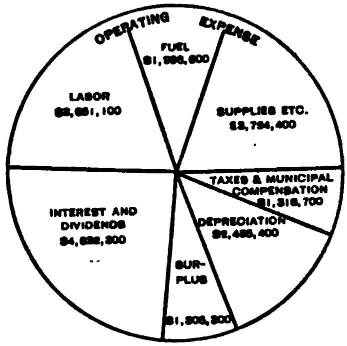


Fig. 37. Distribution of Earnings of Commonwealth Edison Company for Fifteen Months Ended December 31, 1911

Fig. 37 gives the distribution of our earnings for the fifteen months ended December 31, 1910. Our payroll amounted to $3,651,100, or a little over 19 per cent of our receipts. Other operating expenses are as shown, including fuel amounting to $1,996,600, or a little over 10 per cent of our receipts. Our taxes and municipal compensation amounted to $1,316,700, which is about 7 per cent of our receipts. Our insurance amounted to $259,000, about 1.5 per cent of our receipts. Our depreciation and surplus are shown in the diagram, while our dividends and bond interest amounted to $4,632,000, or about 24 per cent of our receipts.

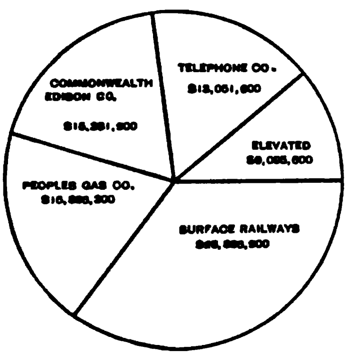


Fig. 38. Gross Income of Chicago Public-Service Compánies in 1911

As shown by Fig. 38 the gross income of all the public-service companies in Chicago amounts to $82,273,600, of which the Commonwealth Edison Company represents $15,331,200; almost as much as the gas company, a little more than the

telephone company, and not quite half as much as the surface and the elevated roads put together.

Of the total amount of electric-service business now possible in this community, we are at present supplying only about one-third, or a little more than one-third, possibly 35 per cent. It takes in round numbers about $75,000,000 to operate our business at the present time. If we were to get all of the business possible to be obtained — that is, if everybody had the same ideas as we have as to the economy of producing and distributing energy electrically — it would in my judgment take nearer $250,000,000 to operate the business of manufacturing and distributing energy within the city of Chicago.

Fig. 39 is a reproduction of a photograph[1] of an old relic that is really very close to my heart. It is the second Edison electric locomotive ever built. It was built and operated successfully in 1882 at Menlo Park, New Jersey, over a track not unlike the ordinary railroad track that you see anywhere in this part of the country, except that the ties were a little higher above the ground than is usual in railroad construction. The system of operating it is about the same as that employed today on the New York Central and Pennsylvania roads, except that instead of having a third rail the two rails operated as the two conductors of the circuit. The road was about two miles long and was operated experimentally during the whole of one year. It was built purely as an experiment, and I think was possibly the first experimental electric railway of any length built in this country and probably the second or third built anywhere in the world. A modern electric locomotive — one of our own — is shown in Fig. 40.

This chart[2] is a comparison of Chicago and New York central-station load diagrams for the maximum day of the year. I think I may say that this diagram represents the

1. The man standing on the front platform of the car attached to the locomotive is Samuel Insull, then twenty-two years old. This is one of the few photographs of the author of these addresses of which publication has been authorized.

2. See Fig. 14 of chapter on "The Relation of Central-Station Generation to Railroad Electrification," page 280.

Fig. 39. Edison Electric Railway, Menlo Park, 1882

Fig. 40. Electric Locomotive of 1912 at Northwest Station, Chicago

Fig. 24. Original (1903) 5000-Kilowatt Turbo-generator of Fisk Street Station, Chicago

Fig. 22. First Storage Battery at Adams Street Station, Chicago

Fig. 25. Northwest Station, Chicago, as Planned in 1910

difference in the policy of the New York companies as compared with the Chicago companies during the last ten years. The Commonwealth Edison Company's load factor represents exactly our earning capacity on our investment. Our load factor in 1902 (maximum day) was 42.3 per cent; in 1912 the corresponding figure was 55.7 per cent. That means that in 1912 we used our investment about 13 per cent longer. And yet the New York Edison Company was only able to employ its investment about 5 per cent more in 1911 than we did in 1902. I do not know of anything that shows more clearly the difference in the character of the business done by the two concerns than that particular curve.

What the Service Means

Some of the financial figures of our business are remarkable. Take those figures that I showed you in Fig. 33. They indicate that the quantity of coal consumed per year is upwards of one million tons; per day upwards of 2,800 tons; and upwards of 120 tons of coal an hour. There were some hours during the winter when probably 250 tons of coal had to be passed over our grate bars. At a time of threatened strike in coal-mining regions — not when the strike is actually taking place, but months before — this company in order to protect the interests of its customers has to accumulate large reserves of coal, 300,000 or 400,000 tons. The incurring of such expense makes the apprehension about as serious as the strike itself would be. I presume that in the last few months, prior to April 1, the storage of coal above the ordinary outlay for fuel will have amounted to upwards of $300,000. Now, we have to do a thing like that from two points of view — our duty to our customers and our duty to ourselves. The steam-railroad trains can stop and stay at one point all winter, if necessary, due to accumulations of snow, a strike of their employees, or whatever unfavorable conditions Providence or man may bring about, and it is forgotten in a day. But just imagine what would happen to a community like Chicago if our service

stopped! The wheels of industry would cease. The majority of the newspapers would cease to be printed. The Postoffice and the Federal courts would have to shut down. In fact, most of those things which contribute to the comfort of modern civilization would have to come to a standstill.

We pay the city of Chicago, as I have stated, $1,058,000 annually for taxes and municipal compensation. That amounts to $2,800 a day, $120 an hour, just about $2 a minute. And yet we are not good citizens!

The $75,000,000 necessary to handle a business such as ours — and I might say in passing that I do not know anywhere in the world where it would be possible to duplicate the business we have and the plants we have for $75,000,000 — costs $4,500,000 a year for interest at 6 per cent. It costs $12,300 per day, or $510 an hour, or not very far from $10 a minute. To you young men who have not been dealing with the problem of how to overcome interest quite as many years as I have, I will say that during all the time you waste in the service, when you ought to be at work, you are wasting a very considerable portion of the interest on the amount of money necessary to run this business. That waste, I may say also in passing, is of far more serious consequence to you than it is to us, because you can get far more benefit out of close attention to your business than we can get out of you if you do pay close attention to your business.

The Commonwealth Edison Company consumes at the present time 10 per cent of the soft coal consumed in the city of Chicago. I mention that to show you what the possibilities of the future are, if the day should ever come when electrical energy can be produced so cheaply, and when the means of conversion into heat become so cheap, that we can use electricity for heating purposes. The possibilities before us are something enormous, so far as the future of the business is concerned.

Here is a rather interesting point. The amount of energy produced by us in 1911 was greater than the entire amount produced by the public energy-producing companies of New York, Brooklyn and Boston, which produce energy for sale;

that is, greater than the entire amount produced by the New York Edison Company, the Brooklyn Edison Company and the Edison Electric Illuminating Company of Boston put together. We produced 716,000,000 units (kilowatt-hours) and they produced, among them, 692,000,000 units.

Lessons from the Career of Edison

I would a great deal rather, on an occasion of this kind, talk to my own people about things that are probably of closer personal interest to them, and which give me a far greater pleasure to talk to them about, than deal with the historical part of our business, as I have felt it necessary to do here to-night. Before I sit down I want to talk to the Commonwealth Edison fellows here. I want to talk to you as I try to talk to you whenever it is my privilege to come before you.

Take the picture that I started with here this evening, the picture of my old chief, Mr. Thomas A. Edison, one of the greatest minds of our age. The only advantage that he had when he started life was the fact that he came from fine old Scotch-Holland stock and came from that "Western Reserve" which has produced so many great men in this country.[1] Probably the greatest advantage he had, above even the marvelous intellect that God endowed him with, was the fact that he had a mother who gave him courage to overcome the obstacles that he must meet. Just consider what that man has accomplished. He is the inventor of our industry. You cannot install a system, whether it is as small as the little system that was started in 1882 at Appleton, Wisconsin, or as great as the great system that we are operating here in and around Chicago today — you cannot in fact install any system for the distribution of electrical energy — without using the inventions of Thomas A. Edison. His patents may have expired; but still to this day you have got to use the same engineering methods that he devised and that he described in his early distribution patents.

1. Edison was born in Milan, Ohio, in 1847.

Now, he had far less opportunity than the average young man who enters our service. I am not talking now about his brains or his capacity for inventive work, but I am talking simply about his opportunities. I remember traveling with him from Detroit to Port Huron, Michigan, some thirty years ago, and hearing him tell the story of the days when he was the "peanut boy" on the very train that we were traveling on, and of what he went through to learn, step by step, the things that enabled him to take advantage of the marvelous intellect that he had been endowed with.

Never do I think of the work Edison has accomplished without trying to recall to my mind the possibilities and the advantages that the men of today have as compared with his situation as a boy of from twelve to fifteen, without education, sitting up nights in a little wayside station, learning to telegraph. Later, landing in Boston in the dead of winter, having so little financial resources that, according to the story I have heard told frequently, he walked into the telegraph office in zero weather with a linen duster on; having so little idea as to the methods to be adopted in educating himself that he went into the Boston Public Library and started on a row of books intending to read the whole library so he should be dead sure to get everything there was there.

When I remember what he went through in his early days and how he kept at work, when I remember his "sticktoitiveness," his desire to "get there," I wonder at the men around me that they do not take more into their hearts the example of that man who stands at the head of our industry and try to emulate some of his efforts. I do not mean to say that you can all be Edisons; I do not mean to say that you can all startle the world with some great discovery in mechanics or electricity; but you can all do the work that is before you and do it to the best of your ability.

Developing the Organization by its Own Brains

Bear this in mind, that the man who only does what he is paid for never gets paid very much beyond just what he is

entitled to, his daily wage. We are engaged in a business that has been operating now something like three decades — I mean from the time of the birth of the incandescent lighting business — operating in this city something like a quarter of a century. The developments of the last few years demonstrate that the economical way of doing this business is to mass the production of electrical energy and distribute it over wide areas. This means the employment in great organizations of an enormous amount of capital, and capital is ever ready to pay for brains. I say again, therefore, that great opportunities are before you in the business in which we are engaged. It rests with you whether you will take advantage of them.

You may think that I am preaching the same story that I preach every time I have a chance to talk to you. Perhaps that is so. I think the chances are that I shall continue to preach just the same story year after year. There is nothing that I like to see so much as the progress of my own people; it does not matter whether it is in my own personal office or whether it is in the organization. There is one thing in my twenty years of managing this business that I am more proud of than of anything else, and that is that I have been able to develop it with the assistance of the brains within the business. I do not know of any case where a man of considerable position has come into our office from the outside. You have simply to go over the list of our officers, of our engineers, and take the people who may be considered as on my own personal staff. Take Mr. Ferguson, who used to be at the head of the testing gang on the street, testing tubes; take Mr. Gilchrist, who, according to my impression, was Mr. Church's office boy; take Mr. Fox, who used to be my stenographer; take Mr. Gulick, who was the bookkeeper in one of the small companies we took in from the South Side; take Mr. Sargent, who was the first engineer of the Chicago Edison Company and who today is the most distinguished designer of central stations in the world. Take all of them; take myself; we have all started the same way. I am a little older than some of you, and yet it is not so many years ago that I used to lick stamps in an office in London.

Just bear in mind what the men who work have been able to do, and remember that you have those same opportunities. Sometimes you may think that there are two or three big fellows ahead of you and that they have got their jobs by favoritism and that you have been put in the background. You may be right; there is one chance in a hundred that you are right on that proposition; but there are ninety-nine chances that the reason you stand still and do not go ahead is because there is something lacking inside of you.

Who Will be the Chief Twenty-five Years Hence?

I make this confidential and very personal talk to you because I have no greater pleasure than to see those around us prosper. We have all of us started the same way. There are very few men in Chicago who have been born with silver spoons in their mouths. Take the great merchant princes in this city; take so distinguished a man as Mr. Marshall Field, who so recently departed from among us. Take men like Mr. George M. Pullman; take the great captains of industry throughout this country today—and they all started from little things.

We are on the threshold of an era when the consolidation of capital for all classes and purposes is going to be something enormous. The price that will be paid for brains will be greater than ever. You are in a business that must be run in large units. It does not matter whether the demagogue or the politician with some axe to grind (usually at the expense of the public) or the rabid reformer, misinformed on the true economics of business — it does not matter if those people say, "We will have no monopoly!" They must have it and we must have it. The only way our product can be sold cheaply in any community is by the establishment of enormous organizations with enormous aggregations of capital producing energy at the lowest possible cost and distributing it in the most economical way. To direct these great enterprises men are wanted. There isn't any reason why this Mississippi Valley, the richest

part of the United States in productive ability, should not obtain the greater part of its men, for the management of the great energy-producing companies that must be established throughout the Valley in the next fifty years, from the boys who are now entering the service of the Commonwealth Edison Company. If we are as reasonably successful as an organization in the next twenty years as we have been in the last twenty years, we will establish such a reputation that the mere fact that a man has worked for us for any length of time will constitute a diploma that will gain him respect and opportunity anywhere in this western country.

All I ask you men to do is to take advantage of these opportunities. The company does everything it can for you. It does it because it thinks it is good business policy to do so. That is the basis on which it is done. It supports this institution[1] because it thinks that if it can raise the average intelligence of its employees their productive ability will be greater. Now, if the productive ability of its employees is of some advantage to the company, how much greater advantage must it be to the men themselves! The company does everything it can in the way of helping you to save your money, putting you in the way of making money, and in return all we ask you to do is to do all you can for yourselves. Incidentally, you will help us.

Probably, after this business has been running another twenty-five years, I will not be standing here, or on a platform corresponding to this, celebrating the half-century birthday; but if the organization fulfills its true traditions the man who then occupies my present position will be someone who at the present time is just on the threshold of entering our service.

1. Referring to the Commonwealth Edison Company Section of the National Electric Light Association.

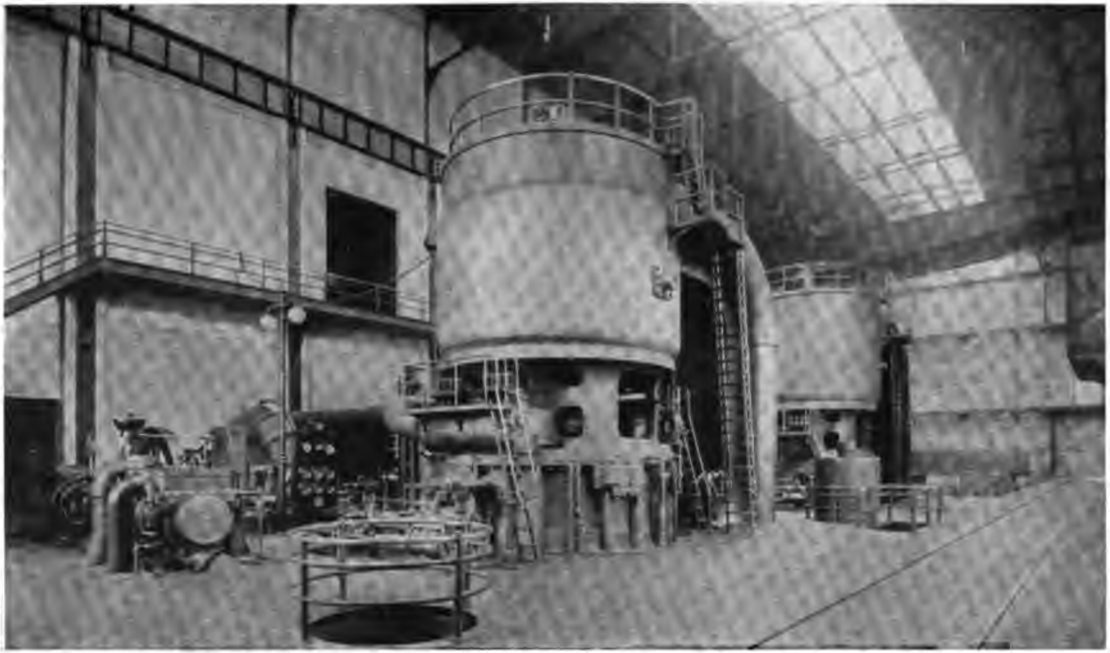
SUPPLYING THE ENERGY REQUIREMENTS OF THE COMMUNITY[1]

PROBABLY the most important thing in connection with the development of the supply of energy in the community is the impressive change that has taken place within a relatively few years as to the size of the units used in the generation of electricity. In this development rests to a very large extent the solution of the economic production and distribution of energy in a community like Chicago and the industrial area surrounding it. If we still had the small units used twenty or even ten years ago, the cost of production would be such as to make impossible the present low cost of energy; and, after all, whether you need the energy for transportation, for light or for industrial purposes, the first essential is to get it at the lowest possible cost.

It is not a well-founded idea, if the production of energy is centralized under one organization, that the electrification of steam railroads means the use of a very large amount of energy.

Owing partly to differences in method of operating and partly to the difference resulting from conditions here in Chicago, we [the Commonwealth Edison Company] are able to get almost a third more use out of our investment than they are able to in most of the other large cities. By combining various forms of business we are able to use the dollar invested in our business about a third longer time, on an average, than the other large producers of energy in the other great centers

1. On May 23, 1912, Mr. Insull gave a brief address before the City Club of Chicago. It was the first of a series of addresses planned by the club and relating to "Chicago's Transportation Problem." Only a part of the speech is reproduced here, as much of the information given, as well as the charts which were used, had been presented in previous addresses.



Vertical 20,000-Kilowatt Turbo-Generators in the Northwest Generating Station of the Commonwealth Edison Company, Chicago

of population of this country. That point has an important bearing on cheap transportation. If the transportation companies produced their own energy, the cost of operating, the depreciation and the interest would be greatly increased. It is the combination of all the various utilities using energy that enables us to sell it to the small consumer on an average cheaper than the price at which it is sold in any of the large centers of population on either side of the Atlantic.

Taxpayers' Money Should Not be Used to Further Economic Waste

The best evidence that cheap power enters into almost every man's thoughts is the way the politicians play upon the proposition. Glowing pictures are drawn of the amount of power than can be produced from waterways within this state, and because water runs down hill it is asserted that the power can all be sold for nothing or at a very low price. Of course, that is simply a dream. I mention the subject because it is very much in the public mind. There are some of us engaged in the energy-producing and kindred businesses who are trying to give this community the cheapest possible transportation, the longest possible ride for a nickel, the greatest possible amount of travel from one part of the city to the other, with the least possible expenditure. I know of no one element, outside of interest and depreciation, that has so important a bearing on that subject, as the question of the cheap production and distribution of energy.

The only way that you can get cheap production and distribution of energy is by concentration, by monopoly. I care not whether I run the monopoly or whether somebody else runs it, whether the capital employed is raised by my friends or by somebody else's friends; but whatever may be the source of the money used, the only economical way to manufacture and distribute energy, to get all there is in it for all the people, is by concentration, by monopoly.

We have in use at this time nearly 400,000 horse-power

produced in the central stations in and around Chicago. Eighty or eighty-five per cent of that energy is produced by one institution employing private capital. Fifteen to twenty per cent is produced by another institution, the Sanitary District of Chicago, employing the capital of the taxpayers. I know of no greater waste of money going on in this community in a public way at this time than in connection with that second operation. It is economically wrong. There should be but one producing system, but one distribution system. I do not care whether the railroads buy from me or whether the city buys from the Sanitary District — it should all be one. You can get more money out of the dollar invested if there is only one system.

While I myself am a great believer in the regulation of all public utilities, I would like to remind you of the results that are being obtained for the customer and the stockholder out of the production and distribution of energy by a company whose rates have never been regulated,[1] whose reductions have always been made of its own free will. The only occasion on which an attempt was made at regulation was during the Dunne administration. Mayor Dunne vetoed the ordinance, and the company put the reduced rates in operation the next day. So we have never been regulated, notwithstanding that we are practically a monopoly and that we are living in a period when monopolies are supposed to be very bad — that is, in their business principles.

You have here in this city a monopoly that sells you energy at a lower price than you can buy it in any city of similar size in the world and can still make such substantial returns to its stockholders that its securities are in good demand.

I think that you gentlemen who take a great interest in the civic welfare of the community in which you live can not do a better work than to do all that you possibly can to insure

1. It was in 1913, after the date of this address, that the five-year readjustment of electric service rates, as provided in the contract ordinance between the City of Chicago and the Commonwealth Edison Company, was effected. The State Public Utilities Commission of Illinois came into existence on January 1, 1914.

the very lowest cost of energy to the producer and the very lowest cost to the user; and the way to do that is to have absolute concentration of production and distribution, whoever that work may be done by.

STEPPING STONES OF CENTRAL-STATION DEVELOPMENT THROUGH THREE DECADES[1]

IT AFFORDS me very great pleasure to have this opportunity to meet so many of the employees of the company over which my friend Mr. Freeman so ably presides. The early part of the Victorian Era gave us steam railroads, gave us gas as an illuminant, and later on gave us the electric telegraph. The decade in which our business first started, namely, in the seventies — that is, the experimental portion of our business — gave birth also to another wonderful development, the telephone. In this country at that time nothing was known of the electric light, except through the work of Brush, Thomson and Houston on series arc lighting, although as early as the winter of 1878 Mr. Edison made his first announcement with reference to his experiments on incandescent lamps. This announcement resulted in a serious fall in the price of gas shares all over the world, owing to the fact that the investors thought that the day of gas illumination had about ended, whereas, as a matter of fact, it had only just about begun.

In the winter of 1880 the first experimental central station was installed at Menlo Park, New Jersey, which at that time was Mr. Edison's home. Fundamentally what he had there is practically what you have today in Brooklyn, if you will cut out your alternating-current transmission lines, and your

1. This instructive and entertaining lecture was delivered before the Brooklyn Edison Company Section of the National Electric Light Association on June 26, 1912. It has been slightly condensed to avoid repetition. However, Mr. Insull drew on the rich fund of his experience for much fresh material and several newly related anecdotes, and care has been taken to preserve these contributions to the history of the art, even though, in doing so, it is necessary to restate basic facts about which the incidents are clustered.

substations, with the exception that the system at Menlo Park was operated on the two-wire system, as at that time the three-wire system had not been invented. He had motors operating his work-shops and he had incandescent lamps lighting the houses. These lamps, it is true, were not of an efficiency of 1.25 watts per candle, as you have today, with 1000 or 1500 hours' life; they took about seven watts per candle, and would burn about long enough to last while you were screwing a lamp in the next socket.

Seven-Watt Lamps Then, but Fundamentals Have not Changed

But still he had there all the fundamentals of a central-station system. The conductors were underground — a thing that at that time, and to my knowledge for two or three years later, was considered absolutely impossible by almost everyone. That is, I do not think there was an electrical man on either side of the Atlantic, except Edison, who thought it possible to insulate copper so as to make it possible to carry sufficient energy underground without extreme leakage.

It was 1881 that the commercial development of the Edison incandescent lighting system started. I suppose I need not apologize in a meeting of Edison men, in talking of three decades of central-station development, if I speak all the way through of that development as an Edison development. You all know just as well as I do that whatever details may have been contributed by others, the fundamental parts of our system, from the generator to the lamp, whether it be the article itself, or whether it be the conception of the great engineering principles that have made our business possible, can all be traced to the marvelous genius of the man whose name we all work under.

As I came down Fifth Avenue, New York, this morning, my eyes turned, as they always turn whenever I come down Fifth Avenue, to 65 Fifth Avenue. It is a brownstone building, a little south of Fourteenth Street. In appearance the

building has changed somewhat in 31 years, but to me it is the commercial birthplace of this great industry. Between the time that it was my privilege to receive the offer from Mr. Edison to come to this country to work for him, and the time of my arrival, he moved his operations from his laboratory at Menlo Park to 65 Fifth Avenue. His reason for doing this was that the work, so far as its purely laboratory experimental stages were concerned, was relatively through. The work that was ahead of him at that time was the commercial development and what you might call the commercial experimenting in connection with the starting of the business. The Edison Electric Light Company that financed Mr. Edison's experiments took the building at 65 Fifth Avenue, and Mr. Edison established his offices there.

Commercial Development of Electric Lighting in the Eighties

At that time (I am speaking of the early days of March, 1881, just after the Edison Electric Light Company's office was opened at 65 Fifth Avenue, New York) there was not a single factory in this country or in Europe where you could obtain generators suitable for the work. There was not a factory on either side of the Atlantic where you could obtain the conductors necessary to convey energy, and there was not a lamp factory in existence where you could get lamps manufactured. There was a small experimental lamp factory at Menlo Park, which has since disappeared. My old friend, Mr. John Kruesi, had just taken a shop at 65 Washington Street, New York, for the manufacture of Edison tubes; and a few days after my arrival here, Mr. Edison leased from Mr. John Roach, the ship-builder, his old Aetna Iron Works on Goerck Street, between Grand and Houston streets, over on the East Side of New York. But it was well into the summer of 1881 before it was possible to turn out dynamos, to turn out conductors, to turn out lamps, for use on the first central-station system.

Just imagine, if you can, that by the wave of your hand you

could bring about such a condition of things that all the thousand and one articles used between the generator and the lamp were to disappear, and you had to start over again to create them. Now that was the situation existing in the spring of 1881. We had a few clumsy wooden sockets and some enormous contrivances that went under the name of switches. We had not even any insulated wire. We used in the first year of the business a wire which I think was erroneously named "underwriters' wire." It had about the same insulation as weatherproof wire has today; only the compound used was paint and was not nearly as good as the compound you now use on weatherproof wire. We had a few wooden cleats. I do not think in the early days we had got as far as to use molding. Yet notwithstanding the fact that everything had to be created — that all that had been demonstrated in the experimental plant at Menlo Park was the feasibility of the scheme from an electrical point of view — the first central-station in New York, which I think was at 255–257 Pearl Street, just south of Fulton Street, was built and put in operation some time in September, 1882.

A Sleepy Private Secretary and a Friendly Policeman

Let me relate a personal incident in connection with the building of the first system in New York. I remember that during the summers of 1881 and 1882 the weather was somewhat warmer than it has been in New York and Brooklyn today. My friend Mr. Kruesi used to superintend the manufacture of the two-conductor Edison tubes by day, and Mr. Edison and Mr. Kruesi (who were the only two men who knew anything about it) used to spend their nights laying the tubes in the streets and testing the conductors for insulation. I used to have to work all day myself on the business end of affairs; but I was anxious to get some technical knowledge of the subject that was being dealt with. I do not know whether it was curiosity, ambition, or what it was, but I wanted to know what was going on; and I used to go downtown toward evening, about

four nights out of seven, with Mr. Edison — the other three we had to sleep — and my job was to watch a galvanometer.

I got a closer acquaintance with the police then than it has been my good fortune to get since. During the weary hours when I was watching the pointer of the galvanometer, and wondering what I was doing it for, and wondering what they were finding out about it, I would doze off to sleep; and when the figure of Mr. Edison or Mr. Kruesi happened to come around the corner, my friend the policeman would give me a poke with his night-stick, and by the time the one gentleman or the other got to the corner of Ann and William streets, or Nassau and Fulton streets, I would have my story about correct as to what had taken place. Of course it was only a question of a very few nights before they found out, and got some fellow who could keep awake.

Edison Risked His Private Fortune

While the first central-station system installed ultimately proved a financial success, in the early days of its operation its customers were relatively few, although its service was extremely good. I think it ran for about 14 months without a breakdown, which was a remarkable record for a primary commercial experiment. The capitalists who had supplied the first million dollars necessary to build this first system lost heart, and I think it redounds very greatly to the credit of Mr. Edison that, besides risking what personal fortune he had at that time in the development of manufacturing establishments to produce the apparatus necessary for use in connection with his system, the financing of the operating system itself was done by Mr. Edison to the extent of several hundred thousand dollars until the operation of the Pearl Street plant had arrived at a point where the capitalists regained confidence enough to supply more money. I don't know whether even Mr. Edison would remember today that such was the case. Probably I am the only man living who had to do with the details of the venture who knows that the facts are as I have

stated. I made up my mind that I would make this statement here tonight as a matter of record to show how far Mr. Edison's unbounded belief in his own invention went.

I can well remember, as recently as 1884, that everything that Mr. Edison had — and he had started as most of us started: whatever he got was from the work of his marvelous intellect — I say I can well remember that as late as 1884, with every dollar he had risked in this business, he asked me one day whether I thought he could clean up and be out of debt, and that if he went back to telegraph operating, whether I thought I could make a living by going back to shorthand writing.

How the Three-Wire System Came into Being

If my recollection is correct, it was in the winter of 1882 that Mr. Edison came to the conclusion that in order to get a great commercial development it was necessary to provide a system of distribution requiring less copper than the two-wire system. At that time he had transferred his experimental laboratory, much to the regret of the men who were responsible for the financing of the establishment, to the shops of the Edison Machine Works on Goerck Street, the predecessor of the present Schenectady works of the General Electric Company. I remember going down there one winter night in 1882, just by accident, and seeing Edison's first experiment on the three-wire system. He hadn't set the mathematicians at work at that time to see how much copper could be saved. He was simply taking a short cut, and seeing whether it was possible to operate a three-wire system. He had the two brushes on the dynamo in their regular position and a third brush on the neutral point. A neutral wire was stretched across the room with the other two wires. Lamps were connected on each side. As the machine was only about a 100-volt machine, he had 50-watt lamps burning on each side of the three-wire circuit. And that was all the experimenting there was to the three-wire system!

There was a lot of theorizing as to what the saving was.

The inventor was pretty deaf even at that time. I shouted to him, and said: "Mr. Edison, how much copper do you think that will save?" "Oh," he answered, "you are alway looking at it from the dollar point of view!" He added: "I think it will save about two-thirds." And I think two-thirds was about what it did save. At the same time Professor Hopkinson in England and Werner von Siemens in Germany were working on the same idea. I am under the impression, although it is many years since I read the record, that Professor Hopkinson thought it possible that 25 per cent of copper could be saved. I don't know the percentage which von Siemens thought could be saved.

But that little experiment in the workshop on Goerck Street was the thing that gave impetus to the central-station business. At that time we were looking for something to enable us to start central-station systems in small towns. The capitalists in the larger cities were not prepared to go ahead. After the start of the station in New York and the one in Appleton, Wis., in 1882, a small station in Dijon, France, was put into service on June 8, 1883. During the same year there were relatively small stations started in Santiago, Chile; Milan, Italy; Manchester, England, under the supervision of Professor Hopkinson (who, as I have just stated, also worked on the three-wire system), and at Holborn Viaduct in London. The great uncertainty of the investment, the great risk that the capitalists thought there was in putting money into the business, led us, as I have said, to endeavor to cheapen the system and apply it to small towns.

Edison as an Electrical Engineer

Our electrical engineering was always good. There were not quite as many electrical engineers with parchments at that time; but we had one man who was very careful to see that the electrical engineering was good, and that was Edison. But the steam engineering was wretched. We tried to make it as cheap as we possibly could. We went through the small towns in Massachusetts and in Pennsylvania and Ohio, and

endeavored to start small plants. I had the honor to run the department that installed the plants. It was called the Thomas A. Edison Construction Department, and some fellow who was a little quicker at repartee than he was at accepting responsibility called it the "Destruction Department," because of the numerous troubles we had in starting stations and operating them. While we got a few million dollars invested in the business, it is probable that by 1885 there was not much more than $5,000,000 invested in the central-station business. Of course when I speak of the central-station business, I speak of a multiple-arc system from which energy can be taken for all kinds of work. I do not consider the series arc-lighting plants, which were general throughout the country at that time, as serious attempts at central-station service.

In 1885 the records show that there were about 400 lighting companies, but most of those were series arc-lighting companies, and the probability is that at that time there were less than 50 or 60 companies, and all of them small, giving electrical service; that is, distributing electrical energy 24 hours a day and 365 days in the year.

In 1885 my friend Mr. Edward H. Johnson made an effort to raise the capital to start a central-station system in another large city, and he picked out Boston for the purpose. So far as my recollection serves me, if it had not been for the money put into the enterprise by the Edison Electric Light Company (that is, the patent-owning company), some assistance rendered by the manufacturing companies, and the personal subscription of Mr. J. Pierpont Morgan, who always was a warm friend of the Edison central-station business — if it hadn't been for those three elements, it would have been impossible to provide the capital to build a station in Boston.

The Industry Established in One Decade

The station was started, I think in February, 1886, and the distribution system was by overhead wires. I believe it was not until two or three years later that the first ten miles of underground conductors was installed. It is interesting to

note that the first alternating-current system, which has done so much for the industry in its larger development, was started the same year (1886) by the Westinghouse Company at Greensburg, Pa.

In 1887 the building of the first Chicago station was commenced on the site of the present 120 West Adams Street building. The station was finished and put in operation on August 6, 1888.

The closing years of the first decade of central-station development were signalized by the first electrical congress and exposition of any consequence held in Europe, and which was held at Paris, in 1889. In that year, I believe, the first Brooklyn station was put in operation. It is rather interesting to note that it was at the Paris Electrical Congress of 1889 that the watt was authoritatively defined as the unit of electric power. Prior to that time we did all our metering on a lamp-hour basis, and for many years after that most of the Edison companies did their metering on lamp-hour basis.

It was about this time that stations were started generally throughout the world. The English manufacturers had become interested in the industry, and more especially the great house of Siemens & Halske, of Berlin, became interested in the industry. The first plant was built in Berlin in the later eighties, and about 1887 the first modern type of machine with direct-connected generators, made in the shops of Siemens & Halske, was installed in the first station of the Berlin company.

It took about three decades, thirty years, to establish the commercial value of gas. Owing partly to the differences in general conditions of living, and partly to the better original invention, it took but one decade to establish the commercial possibilities of the electric-power and electric-lighting industry.

Great Expansion of the Second Decade

We now enter upon the second decade of central-station development. As I have said, the first decade was occupied

with laboratory experiments and what you might call the commercial experiments; but it was in the second decade of the business that the real commercial development took place. I am inclined to think that the main causes for the great increase in the business from the year 1890 to 1900, which practically forms the second decade of central-station development, can be traced to the commercial end of the business entirely. In the early part of that period, the first half of that period, the years extending from 1890 to about 1895, we first began to learn something about the underlying principles necessary to be mastered in order to produce a proper balance sheet. In other words, we first began to learn something about the way to sell our product. I think it is a fair statement to make that there was not a man in the central-station business prior to 1890 who understood anything about the principles controlling the proper disposal of the product that he manufactured.

While Europe had to come to this country to learn something about the underlying principles of engineering of central-station development, we had to go to Europe to learn something about the principles underlying the sale of the product. I think we owe more to Mr. Arthur Wright, who sometime in the early nineties was the manager of the municipal plant at Brighton, England, than to any other one man so far as teaching us the fundamentals governing the sale of our product. I have no recollection of hearing anything, except in the most general terms, about load factor, or the necessity of long-hour customers and the desirability of selling to them at a lower price than to short-hour customers, until I first met Mr. Wright, and saw what he was doing in that direction in the city of Brighton.

The lessons he taught us are the commonplaces of today. We still have a few people who don't agree with us, or who sell their product on what we call a flat-rate basis; but I suppose 99 per cent of the people in the central-station business have come to the conclusion that the only way to sell energy is on a basis that gives to the man who uses it the greatest amount of time during a given period the least possible price.

The reason I am dwelling on this particular point is because I wish especially to present to you here this evening the great importance of the commercial element in the development of what is an engineering business. The sale of our product in larger quantities than it had been sold heretofore, starting, as I say, in the nineties has, in my judgment, been the main cause which has forced most of the developments that have taken place since the original three-wire system was brought into use, and since the first alternating-current plants were established by the Westinghouse company.

This large-quantity sale led to a greater density of energy consumption in a given area. That led, of course, to greater demands for larger sized generating units, and that led to the production of modern types of engines of larger sizes as compared with anything we had used with belted generators, and ultimately to other developments.

The first electrical power transmission system established in this country was established in 1890, connecting a small Colorado town with a mine some miles outside the town. The year 1891 gave us direct-connected units in this country of higher efficiencies and lower speeds. The year 1893 gave us the World's Fair at Chicago, which, above everything else that had occurred up to that time, was an electrical display and one that was well worthy of the development that had been attained in the art up to that date.

In 1894 the most economical station built up to that time was started in Chicago — the Harrison Street station — with modern types of marine engines. I think it was the second or third station of that kind built in this country. There was one here in New York, and another in Milwaukee, I think, that preceded it. But it was the first time that energy had been produced at anything like a moderate cost — a cost which, however, more nearly approaches our selling price of today than our cost.

Probably the next most important development that took

place was copying the experiences of the first transmission system in Colorado, and also more formidable work of the same character that had taken place in Europe, and applying it to central-station practice. The first rotary converters used in connection with an Edison central station anywhere were started by the Brooklyn Edison Company and the Chicago Edison Company in October, 1897, and I believe the engineers of the two companies are still disputing in relation to the claim of priority.

Large Units Introduced in the Third Decade

This brings us to the modern central station and distribution system. The three-wire distribution system, the rotary-converter station, the high-tension transmission cables and the direct-connected large-sized reciprocating-engine alternating-current units form what was in the year 1900, or a little later, the best form of modern central-station practice. The massing of production of energy in large quantities, the cheapening of the relative cost of investment and the cheapening of the cost of operating — in fact, the lessons learned through the second decade of central-station development, which was the period of commercial development — practically forced the introduction of still larger units as prime movers. The reciprocating engine reached its limit, practically, at 5,000 to 6,000 kilowatts. Six thousand kilowatts is a pretty high amount for a reciprocating engine to produce, and those of us who were engaged in the distribution of large amounts of energy were looking for some other means of central-station production. That was at the close of the second decade of the development of our business.

The steam turbine, developed by the Hon. Sir Charles A. Parsons in England, had gone along relatively slowly. We had seen one or two of them in this country. I think my friend, Mr. Bowker, brought the first one to the United States. (Mr. Williams[1] corrects me and says that the first turbine brought

1. Mr. Arthur Williams, general inspector of the New York Edison Company and past-president of the National Electric Light Association.

here by Mr. Bowker was the De Laval.) Then the Westinghouse Company brought over some small Parsons turbines, and Professor Curtis commenced his experiments on what has been developed into the Curtis steam turbine, as made by the General Electric Company.

I can well remember, as a result of a trip made by Mr. Frederick Sargent, our consulting engineer, and Mr. Louis A. Ferguson, our second vice-president, to Europe, I think about the year 1899 or 1900, that I was ready to listen with a more receptive ear to the suggestion of Mr. Coffin, president of the General Electric Company, that he should build a steam turbine of the Curtis design for one of our Chicago stations.

Some Inside History about the Fisk Street Station

Mr. Coffin wanted, on the advice of his engineers, to build a 1,000-kilowatt machine, or a 1,000 horse-power machine — I forget which. I pointed out to him that we had reached a point in central-station development that enabled us to get reciprocating engines of 5,000 or 6,000 kilowatts, and that to make a steam turbine of a fifth that size would be a step backward. We had long negotiations on the subject, and it resulted in the General Electric Company building for our Fisk Street station in Chicago the first large steam turbine of any make erected and operated on either side of the Atlantic. The shell of that turbine, I believe, has been erected as a monument to the art in the yards of the Schenectady works, and to my mind it is a monument to one of the greatest developments that has taken place in connection with our industry.

The ability to mass very large amounts of energy production, the ability to do that at a very low investment cost, and to produce the energy from such machinery at an operating cost never heard of with reciprocating engines and at an efficiency never heard of with reciprocating engines, has, to my mind, had a greater influence on the development of our business during the last decade than any other one thing. True, we were looking for some means of producing energy in greater

Typical Substations of the Commonwealth Edison Company, Chicago

Sixty-second Street

Whipple Street

Harding Avenue

quantities at lower cost, and under circumstances of greater reliability than production could possibly be with a reciprocating engine, as compared with the low investment cost, low bearing cost, and great reliability of a rotating prime mover; but the fact is that in agreeing to take the risks of manufacture, and to give the industry something which it needed badly, I think the central-station side of the business owes a great deal to the courage of my friend Mr. Coffin in developing the turbine business in this country rather from the point of view of large units downward than from the point of view of small units upward.

The history of the last decade, bringing us directly up to today or yesterday, has been one of marvelous progress in our industry, but, to my mind, it is but the start of what we can expect may come in the future.

Present-Day Massing of Production

It seems to me that the true function of a central-station company is to produce all of the energy used in the community, not necessarily limited to the territory in which it now operates, but in the community of an area which it can economically reach. Some years ago I used to talk, whenever I went to Europe, with my friend Dr. Rathenau, the head of the great Allgemeine Electricity Company of Germany, on the subject of central-station areas. I think I first got from him the idea that I should look a little beyond my nose, and see if there was not some territory outside of the narrow limits in which I was then operating which could be economically reached from a large generating station. I do not think we have any conception of the savings that can be effected by concentration of production and distribution. I have tried to figure somewhat on the subject myself; but when one takes into account the remarkable growth of the large centers of population, especially in this country, it is almost impossible to figure the possible savings that can be produced by concentration of production and concentration of distribution.

We are living in an era when our public men look askance

at the encouragement of monopoly — generally industrial monopoly — but fortunately we are engaged in a business which, it is generally recognized, can be run more economically as a monopoly, and which is generally subject to legislative regulation.

Cultivate the Good Will of the Public

Before I take my seat I want to talk to you the same way that I talk to my own "boys" on the subject of your personal responsibility to the business in which you are engaged. I always say that it makes no difference to me whether the position occupied by a man be that of general manager or coal passer. More or less all men who work for public-service corporations are in the public eye. I do not care whether it is the head of the business, whose name most frequently appears in the newspapers, or whether it is the man occupying a subordinate position — both are in the public eye, so far as our business is concerned. If our business is to be permanently successful; if we are to obtain and hold the good will of the communities in which we operate; if we are to be allowed by the governmental bodies having charge of such matters, whether legislative or administrative, to extend our monopolies — we must defer to public opinion. I think that all our people should try to achieve the highest possible standing in the community in which they live. They should bear in mind that their personal conduct for good or ill is an addition to or subtraction from the good will which the public bears towards the business on which we are all dependent for our livelihood.

I do not know of any business that offers the opportunity to the average man, not necessarily to the man of great ability, but to the average man, as that offered by our business. I do not know of any business that is less affected by changes in general conditions of business than our business; that gives greater continuity of service. The message that I want to leave with you is one which will lead every man in this room to feel a personal responsibility with relation to the success of the Edison Electric Illuminating Company of Brooklyn.

THE PRODUCTION AND DISTRIBUTION OF ENERGY[1]

THE FIGURES that have been so ably presented are certainly somewhat staggering. I do not think I have ever heard them presented in exactly the same form before. While it is my duty tonight, and my pleasure, to address you on the subject of the generation and distribution of energy—that is, electrical energy—I have no intention, except in the most incidental way, to refer to the work that we are doing in Chicago. Whenever I have addressed a similar body on the subject of the economical production and distribution of energy I have usually referred to the means of production in great cities and the distribution of energy for use in those cities, and have tried to demonstrate that the truly economical method to pursue is the manufacture and distribution of all such energy under one organization. In discussing this subject, especially in the address given in the city of New York, before the American Institute of Electrical Engineers about a year ago, I have referred to the necessity of having very large prime movers—a necessity which undoubtedly exists, in order to get economical production in large cities; but this

1. A lecture delivered before the Franklin Institute in Philadelphia on March 19, 1913. In this address the author gave the most elaborate and scientific exposition that he had yet attempted of the benefits of concentrating the production and distribution of electrical energy over wide areas. The Franklin Institute of the State of Pennsylvania, to employ the official name, was incorporated in 1824. During its long and honorable career it has disseminated much information on nearly every subject connected with the useful arts. To a considerable extent the *Journal of the Franklin Institute* has been the medium of this communication. The present chapter is reprinted, with a few changes, from that publication. Mr. Walton Clark, as president of the Franklin Institute, introduced Mr. Insull. In doing so he sketched briefly the rapid development of Chicago's electrical interests, giving figures and data, referring also to the active part taken in such development by Mr. Insull. The opening sentences in the text refer to the introduction.

evening I intend to give my attention, and to ask you to give your attention also, to exactly the opposite point of view. I purpose to take the smallest prime movers that I have had anything to do with in the smallest generating stations in the rural and agricultural territory of Illinois, and, starting from that point, to draw your attention to the various uses to which electrical energy can be put in performing the various duties required of it, for the benefit of the local farming community, the small country towns surrounded by such farming communities, the lowlands of the state requiring drainage, the mines of the state requiring electrical power, and the interurban roads traversing the state and requiring energy for the propulsion of their cars. If time will permit, I will endeavor to show you that the true economic method of the production and distribution of energy for all these purposes, and for some other purposes to which I will incidentally refer, necessarily involves, so far as a state-wide service is concerned, concentration of production, concentration of distribution, and, if you may choose to call it so, monopoly of administration of the business of producing and distributing electrical energy.[1]

Electrical Requirements of Lake County, Illinois

I now come to the main part of my lecture. The reason I have chosen the Lake County district and surrounding territory, shown in Fig. 1, which is the extreme northern corner of Illinois, facing on Lake Michigan, is that this probably is the poorest territory for the purpose of central-station distribution that it has been my fortune to operate in. The plants were acquired in that territory in the year 1910.

The towns marked by the crossed-circle emblem are twelve in number, with a population of 7,886. Those marked by a solid black dot are the only towns in the territory which had electric service, and that at night only.

1. Mr. Insull here repeated four of the charts showing the energy requirements, with diversity factors, of New York and Chicago, previously given in his A. I. E. E. address on "The Relation of Central-Station Generation to Railroad Electrification."

The next chart, Fig. 2, shows the condition two years later, in 1912. There are only two places in the county without electric service. There are twenty towns served, having a population of 22,188 people, and there are 125 customers, which are mostly farmers, outside the corporate limits of any of the villages in that territory.

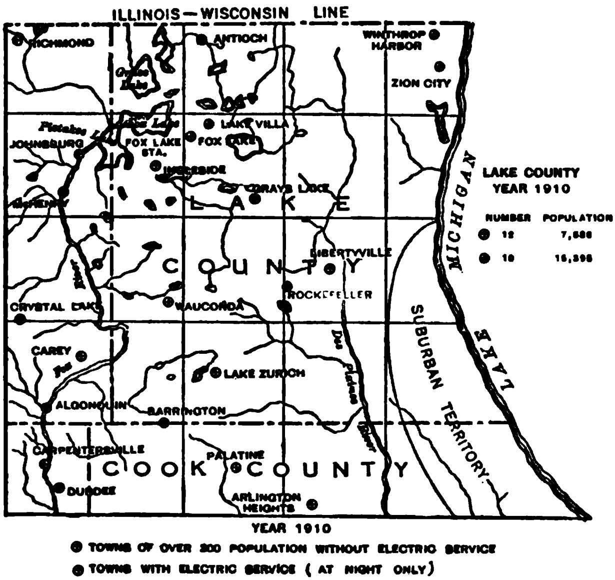


Fig. 1. Map of Lake County (Illinois) District in 1910

Fig. 3 shows the distribution system outside of one of the villages which serves a number of farms. Some two years ago, when that territory was taken over, an isolated plant was acquired which a gentleman farmer who had a very large farm in this vicinity had installed and which supplied a few of the neighboring farmers in addition to the owner's requirements, forming the nucleus of the rapidly developing load of this territory. The main circuit is installed on the same poles with the transmission lines.

The monthly variation in energy used on 68 farms is shown

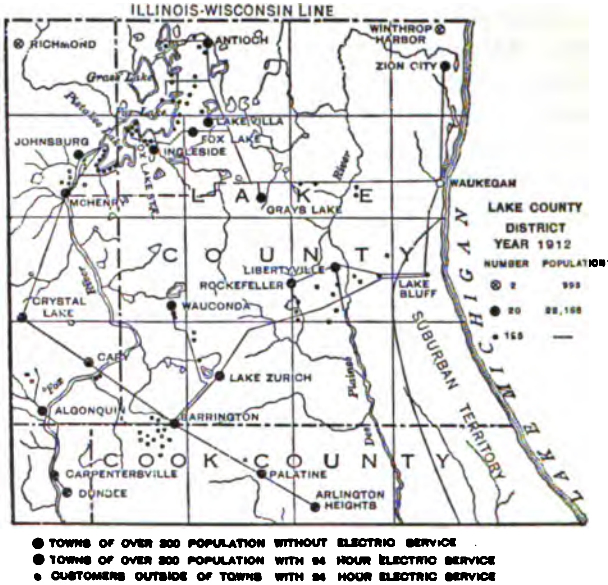


Fig. 2. Map of Lake County (Illinois) District in 1912

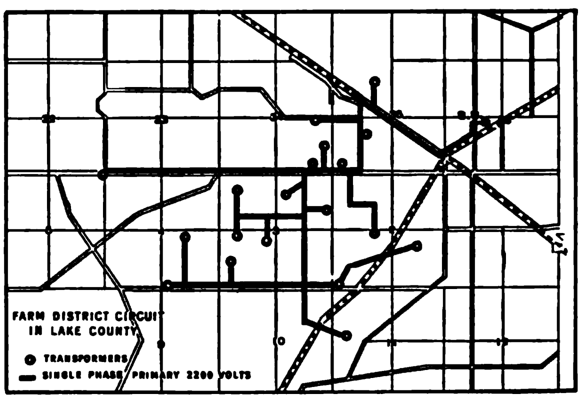


Fig. 3. Rural Distribution System

in Fig. 4. The annual kilowatt-hours for light were 23,609 and for power 62,259. The lighting was 27.5 per cent of the total, and the power 72.5 per cent. The highest consumption comes in the middle of summer, which is the opposite time to the highest consumption in the adjacent towns.

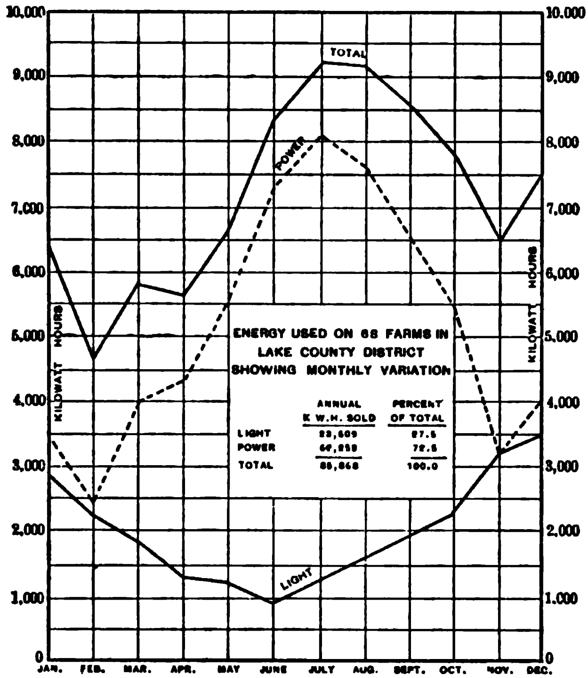


Fig. 4. Use of Electricity on Farms, Illinois, 1912

Two typical farm-load diagrams are given in Fig. 5. They indicate, the same as the previous chart, that rural or farm load has its maximum in summer. They are plotted from actual readings taken at the substation. The maximum occurred on the day before the Fourth of July, and the unusually high evening lighting peak is explained by assuming that the city people came out the evening before to spend the Fourth at their country places.

While these curves may not be entirely representative of general farming load, because there are several large farms owned by wealthy city people whose freer use of electricity probably influences the total, nevertheless they include a

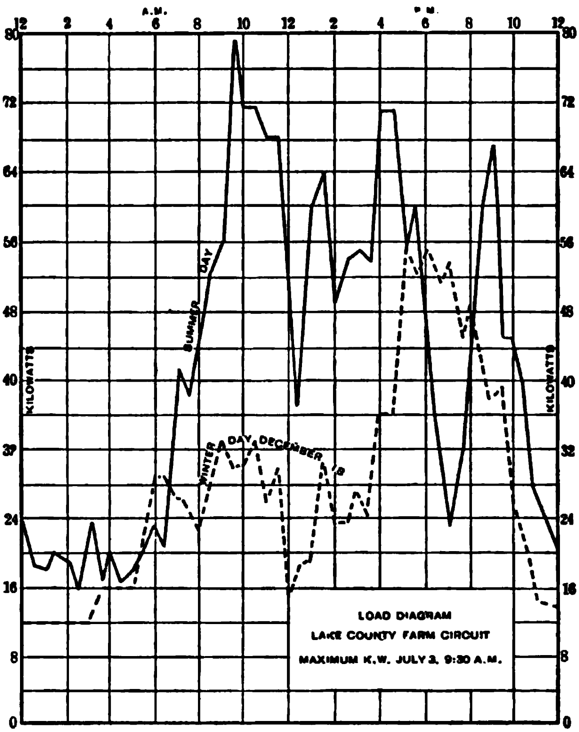


Fig. 5. Typical Farm-Load Diagrams

large number of average-size farms conducted by farmers of average means. The curves are probably an indication of the development that is possible for this class of business.

Table I gives some actual statistics on these same 68 farms. The figure of 2.4 horse-power for motors connected is very low indeed, and should eventually increase several times as this business is developed.

TABLE I.—DATA ON LAKE COUNTY FARMS

Total number of farms	68	
Average acres per farm	162	
	Per farm	Per acre
Incandescent lamps in 50-watt equivalents	30.5	....
Motors in horse-power	2.4	....
Total connected load in kilowatts	3.3	....
Annual light kilowatt-hours	347	2.14
Annual power kilowatt-hours	916	5.65
Total kilowatt-hours	1263	7.79
Income from light	$41.60	26c
Income from power	55.90	34
Total income	$97.50	60c

Fig. 6 shows a comparison of two winter-day load diagrams prorated to the same maximum, in order to show the growth of the day load in the Lake County territory and the consequent improvement in the load diagram and load factor as compared with the average local town plant, of which the diagram of 26 towns recently taken over is typical.

I am dwelling at some length on this particular territory because it is not a manufacturing district and there are very few towns in it. The suburban district tributary to Chicago, as shown by the map (Figs. 1 and 2), has been cut out of the figures.

The annual load-factor figures show what can be done in the way of improvement by unified control. The annual load factor of 26 towns recently taken over was only 22.6 per cent, while the load factor of the Lake County district, after two years of unified control, has been brought up to 28.9 per cent. For comparison, it may be stated that one of the large cities down the state has a load factor of 30.8 per cent, and the Chicago light-and-power annual load factor, exclusive of railway service, is 34 per cent.

Table II (page 365) gives comparison of cost of energy, investment cost and operating cost under the old plan, when there were a few isolated central stations in small towns, with cost of energy for the same territory two years later from a modern station, transmission and substation system. The

total cost of these old stations, not including the distribution systems used in the towns, was $178 per kilowatt. In abandoning these stations and building transmission lines from a town on Lake Michigan, where we could get cheap energy, and

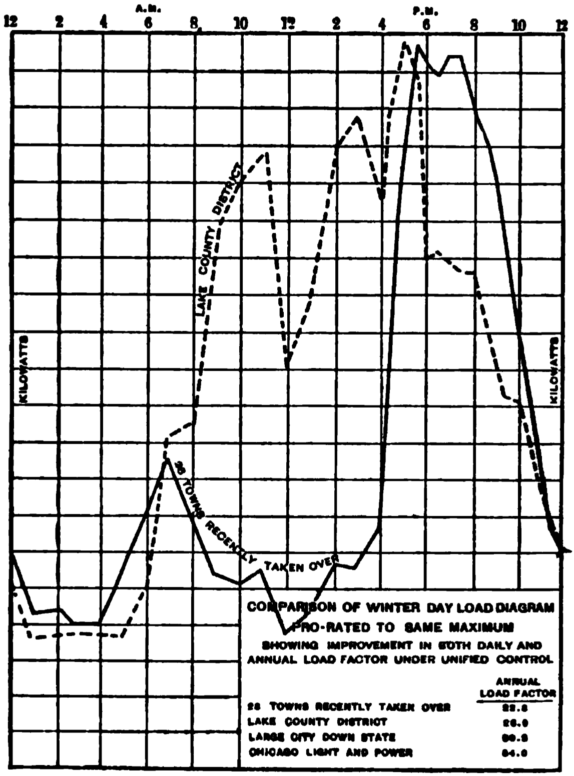


Fig. 6. Diagram Showing Benefit of Unified Control

building local substations, you will see the cost was brought up to $382 per kilowatt. Under the old scheme the fixed charges for investment per kilowatt was $20.85, and under the new scheme two years later the charge was $42.60. These figures would seem to indicate rather a prohibitive proposition, so far as the new scheme of unification is concerned, as compared

with small isolated stations. But if you go a little lower down you will see that under the old scheme we had only 14.6 per cent load factor, whereas with a unified system of power we had 28.9 per cent load factor.

TABLE II.—COMPARISON OF COST OF ENERGY

Lake County District

	1910	1912
Investment per kilowatt of maximum—		
Generating station	$178	$122
Substation	..	70
Transmission	..	190
Total	$178	$382
Fixed charge on investment per kilowatt of maximum	$20.85	$42.60
Maximum kilowatts	573	963
Load factor	14.6%	28.9%
Costs per kilowatt-hour at local plant or substation—		
Fuel	2.04c	.61c
Other operation, including substation and transmission	3.42	.56
Fixed charges on investment	1.62	1.68
Total costs	7.08c	2.85c

Showing a saving in supplying this district from unified power supply and transmission system of 4.23 cents per kilowatt-hour.

Applying these respective load factors to the fixed charges on investment you will find that the fixed charge per kilowatt-hour figures out only a mere fraction higher under the new scheme, owing to the great difference in load factor.

If you go still lower down you will find that the fuel cost under the old scheme is 2.04 cents, whereas under the new scheme it is 0.61 cent. The substation and transmission operating and other station operating expenses are relatively even lower under the new scheme than under the old.

These operating costs include not only the station cost but the operation and maintenance of transmission lines and substations and the losses in transmission from station to substation, also the conversion loss in the substation; but the figures do not include in either case any local distribution expense or general expense. So that when you come to total up

these figures, notwithstanding that apparently you start out with over twice the investment, you will find your base cost per kilowatt-hour at the local lighting plant or substation under the old plan was 7.08 cents per kilowatt-hour, and under the new plan 2.85 cents, showing a saving of 4.23 cents per kilowatt-hour.

Table III gives us some further figures on this same Lake County territory.

TABLE III.—LAKE COUNTY DISTRICT

	Separate management in each town. 1910 conditions	Unified power and transmission system 1912 conditions
Population served	15,395	22,188
Number of towns served	10	20
Number of customers	1,422	3,457
Connected load in kilowatts	2,033	4,503
Kilowatt-hours sold	699,574	1,898,978
Kilowatt-hours sold per capita	45	86
Income	$62,371	$136,694
Income per kilowatt-hour	8.9c	7.2c
Income per customer	$43.86	$39.54
Income per capita	$4.05	$6.16
Maximum kilowatts	573	963
Annual load factor	14.6%	23.9%

REQUIREMENTS OF VARIOUS ILLINOIS UTILITIES

Fig. 7 is a load diagram showing general light-and-power requirements for the maximum day in 26 Illinois towns.

These are the actual load curves for 26 plants, and it will be noted that those for Northwestern Illinois show a very much better day load than those for Central Illinois, probably due to the fact that the Northwestern Illinois properties were acquired about a year earlier and the power load has been better developed. The Lake County diagram still further emphasizes this point.

The total-light-and-power diagram for the state has been

prorated from this diagram, and while this probably gives us the approximate diagram and kilowatt-hour output for the state for this present winter, the improvement in load factor and increase in kilowatt-hour output should be very rapid; that is, we might have estimated the total light and power for the state based on the Lake County diagram, which would have

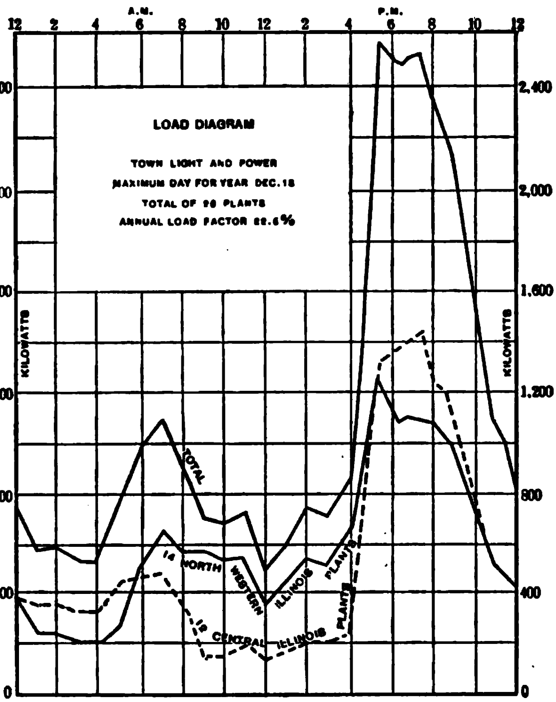


Fig. 7. Maximum-Day Diagram, Illinois, 1912

given a greater output and better load factor and which would probably be a very close estimate to the actual figures.

Fig. 8 is the load diagram of five interurban roads in Northern Illinois. The annual load factor is 47 per cent. The maximum load comes on a summer holiday.

The heavy fluctuations of interurban load require, in case of separate power plant for interurban supply only, a greater

reserve capacity than if supplied from a station serving several classes of business.

The total kilowatt-hour output for the 62 interurban and street railways in the state, outside of Chicago, has been estimated, from these five and two other roads, on three different bases — that is, per passenger, per car-mile, and per car —

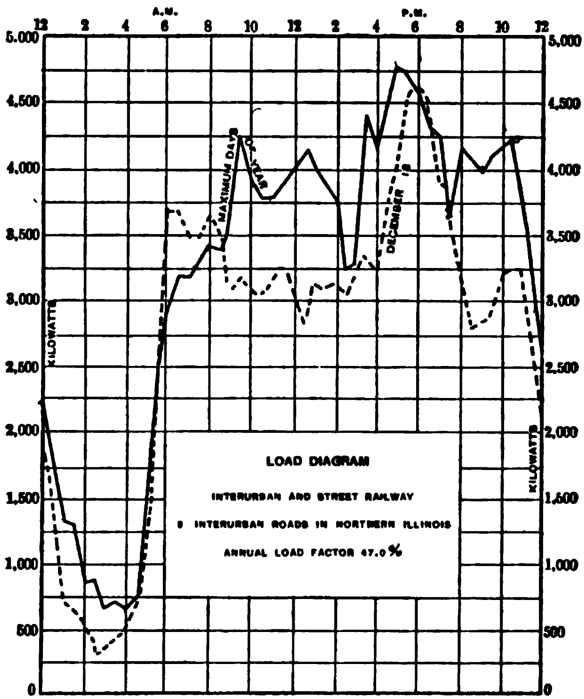


Fig. 8. Railway Load Diagram, Illinois, 1912

and the three figure out very closely. The total curve for the state has been prorated from these curves, using this output.

Fig. 9 shows a water-pumping load diagram of three Northern Illinois plants, the kilowatt-hours per thousand gallons amounting to 2.81. You will see that the maximum comes in the summer, and it is possible so to arrange this production that it is practically off-peak business. Most of the small

water-pumping plants in the small central western towns pump to a reservoir in an elevated position, so that the question of exactly when the pumping shall take place is not a serious matter, except in case of fire. As a rule, that class of business gives a load factor of about 50.5 per cent.

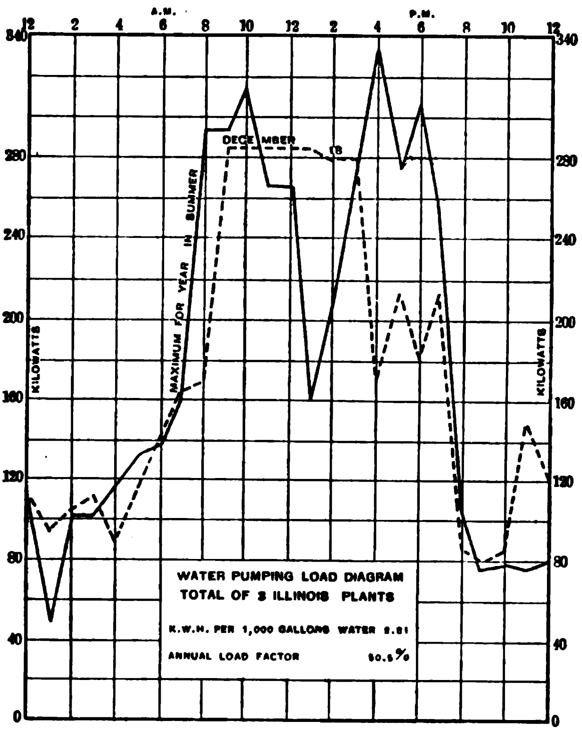


Fig. 9

Fig. 10 shows a diagram of an ice-making load for six plants in Chicago. The motors installed amount to 2,424 horse-power, and the annual load factor is 42.7 per cent. Contracts are made so that the operations shall cease at the time of maximum load for a period of a few hours per day for four or five months in the winter, which is not objectionable in that business. The reason we have taken these six plants is because

they are about of a size that is generally used in the small towns throughout the state, and therefore the load curves would apply equally well to the country as to the city.

Drainage as a Central-Station Load

An entirely different class of business is illustrated by Fig. 11. This map and the data that I give here and on the

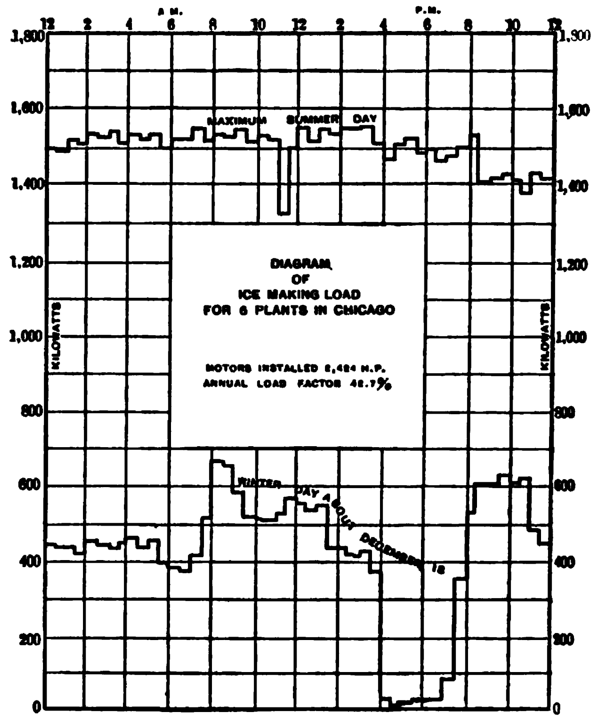


Fig. 10

next three maps or diagrams refer to the Illinois River drainage districts, and we present them as an interesting illustration of the use of electricity from a transmission system.

Between the bluff lines, which run approximately parallel to the river, is a wide flat valley which is subject to overflow at times of high water, but when reclaimed, by building dikes

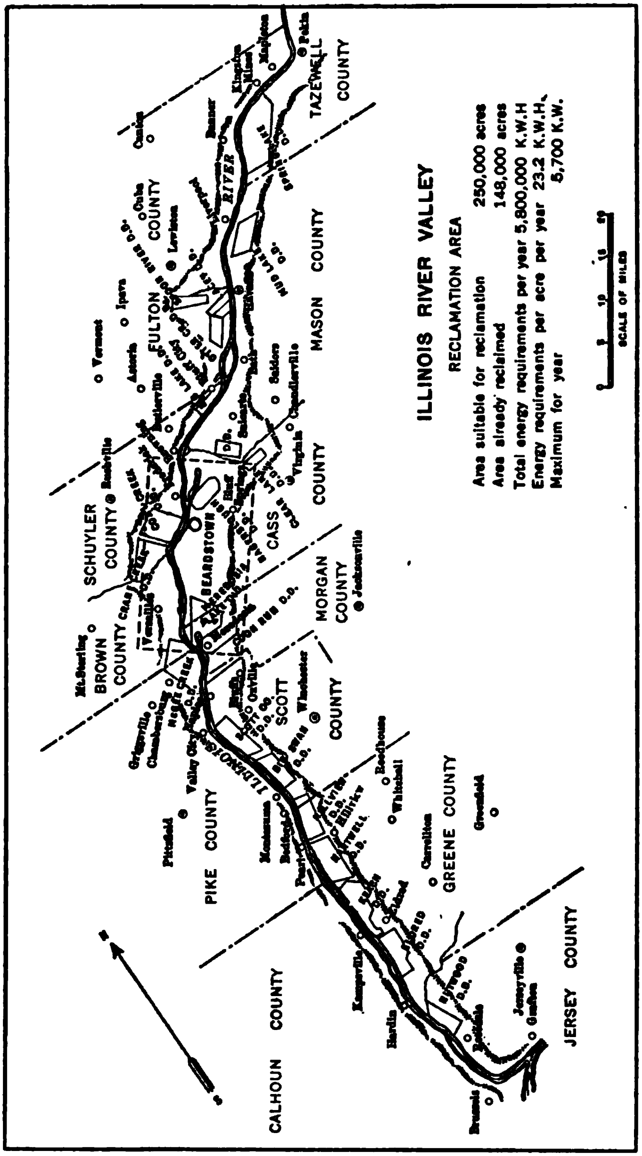


Fig. 11. Map of Illinois River Drainage Districts

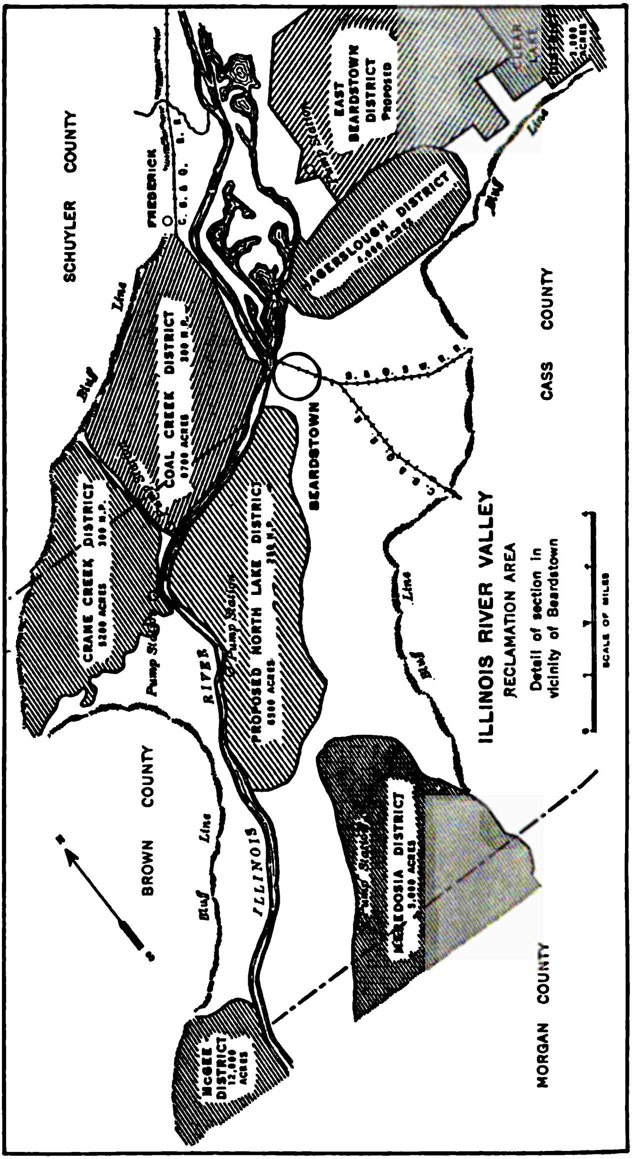


Fig. 12. Detail Map of Illinois River Drainage Districts

around suitable areas and draining and pumping out the surplus water, extremely fertile land is made available. The load factor of the business by itself, being less than 12 per cent, does not warrant the installation of a generating and transmission system for this supply by itself, but when combined with other uses of electricity in the same territory it is valuable

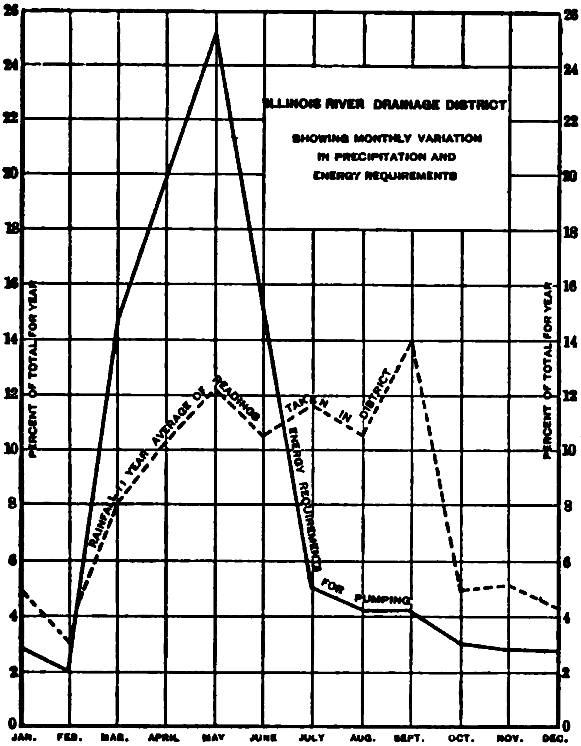


Fig. 13

business, as it is altogether off-peak. A cheap power supply should greatly accelerate the reclamation of swamp and overflow land throughout the country.

Fig. 12 shows in detail one section of the preceding map. You will see the lines of the bluffs on either side, and the shaded areas are the various districts which have already been

reclaimed or which it is proposed to reclaim. The pumping station is always located at the best point in the district to drain all the land and to return the water to the river. It is quite an advantage sometimes to locate more than one pumping station in a district, because of topographical conditions involving quicker and better drainage. This is perfectly

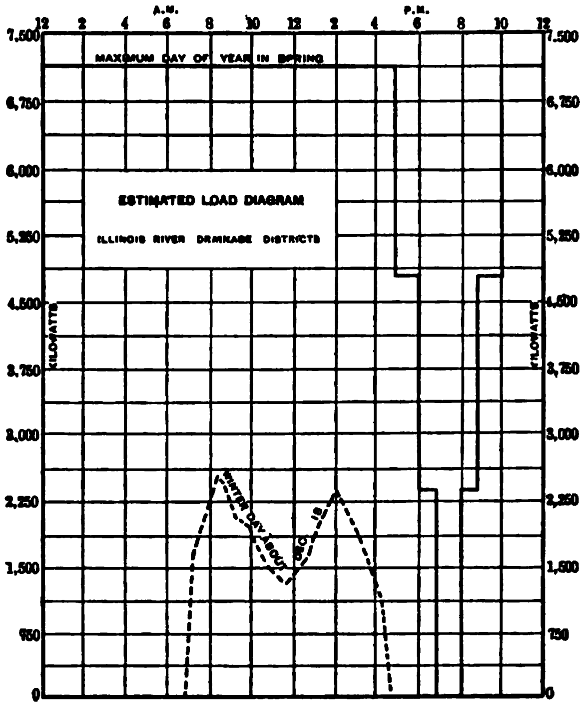


Fig. 14

practicable with motor drive, while it is usually out of the question to build two steam plants in the same district. A co-operative plant and transmission, as was planned for the entire district, involves an expenditure of approximately $1,335,000, while a public-utility company, with transmission lines practically along the entire valley, in order to supply local towns, can take care of this same business at an expenditure of

not over $411,000. The cost of co-operative output per kilowatt-hour figures at least three cents higher than the cost of supply to a public-utility company.

The monthly variation in precipitation and energy requirements is shown by Fig. 13. The high peak there is partly owing to the melting of the winter precipitation stored in the

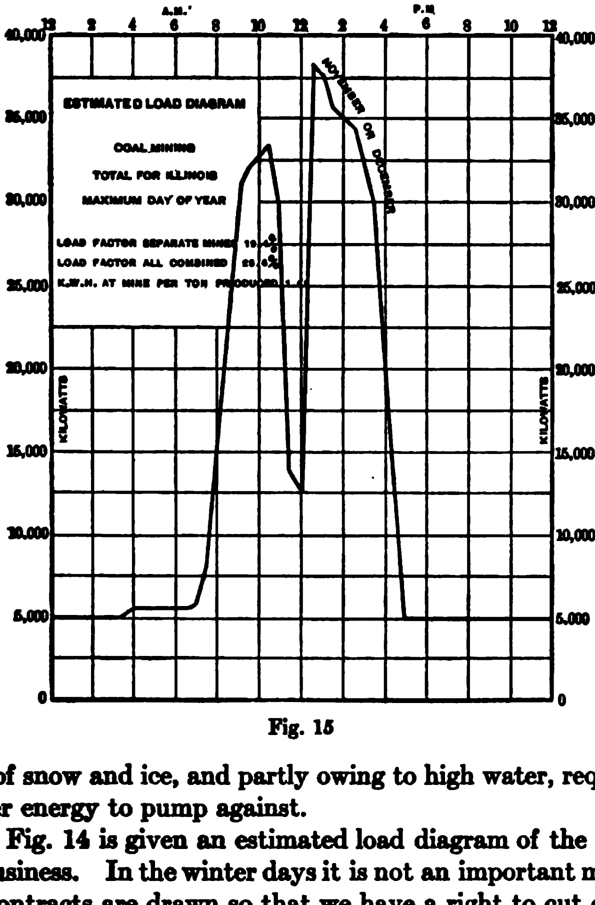


Fig. 15

form of snow and ice, and partly owing to high water, requiring greater energy to pump against.

In Fig. 14 is given an estimated load diagram of the drainage business. In the winter days it is not an important matter. The contracts are drawn so that we have a right to cut off the supply for a period of three hours, and consequently it becomes absolutely an off-peak business.

Coal-Mining and Other Requirements

The coal-mining load (Fig. 15) has been estimated by mining engineers from an experience dealing with the whole state of Illinois and from actual load diagrams of two mines which are operated largely electrically. These data indicate about 1.63

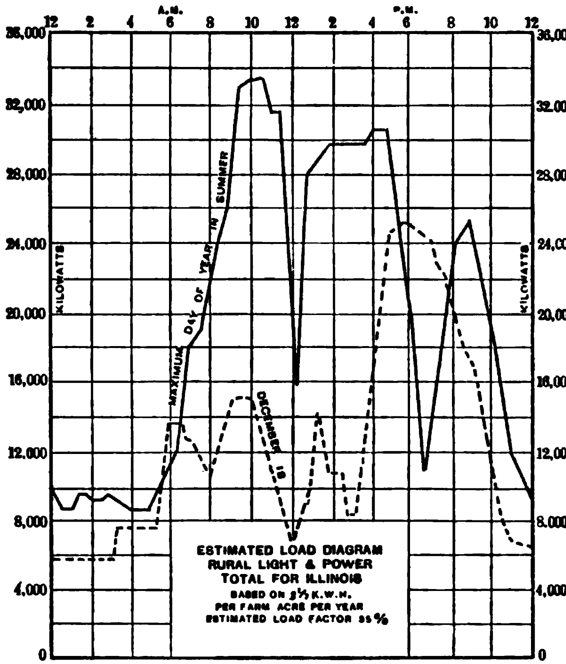


Fig. 16

kilowatt-hours at the mine per ton of coal produced. We applied this figure to the total tonnage of the state, which is approximately 50,000,000 tons, produced by 845 mines. Of these, 586 mines, producing about 5,000,000 tons, are eliminated as local mines too small to equip electrically. There is added the estimated load for some forty washing and re-screening plants, and then transformer and line losses. The load factor for the individual mines figures about 20 per cent, due to the

fact that the mines are operated only a little over one-half of the number of days per year; but there is considerable diversity between the mines, as one day a mine or group of mines shuts down, and another day some others, so that the load factor for all the mines is brought up to about 25.6 per cent. Further, the diversity is large, as it is practically off-peak business, the men all quitting work at 4 p.m. and being out of the mines before 4:30 p.m., that being earlier than the average evening load for other purposes in the territory.

In Fig. 16 is shown a load diagram of the total power for rural Illinois based on 2.5 kilowatt-hours per farm-acre per year. We have taken the Lake County figures of 7.79 kilowatt-hours per farm-acre and cut it two-thirds, so as to be absolutely safe in our figuring. The Lake County figures, to my mind — as we had only two years to make any development — are very low indeed, and I believe that the maximum demand for an ordinary farm will greatly exceed in future years 7.79 kilowatt-hours per acre, so that we cannot go very far wrong, so far as minimum possibilities are concerned, if we take one-third of what we are doing and assume that to be the consumption per farm-acre. You will notice the load factor is 35 per cent, and that the maximum, as I told you before, comes in the summer.

Electrical Requirements of the State of Illinois

We come now (Fig. 17) to the marshaling of the figures that have been given in the previous curves. We take the state of Illinois, outside of Cook County and outside of a small suburban district in Lake County, and we find that on the lowest possible estimate the total light and power is 99,800 kilowatts on December 18th. The interurban and street railways used 81,500 kilowatts on a summer holiday, when their maximum comes. The town water-pumping takes 29,290 kilowatts and the ice-making 16,575 kilowatts. Coal mining takes 38,530 kilowatts between 4 and 4:30 p.m. some day in November or early in December. The rural light and power takes 33,125 kilowatts in the summer. Drainage pumping re-

quires 7,125 kilowatts in early spring. Thus we have a total of 305,945 kilowatts if you disregard altogether the time at which the maximum demand comes.

Now the generating plants, the transmission lines and the substations have to be designed and constructed to take care of the maximum demand made on you on one given day of the

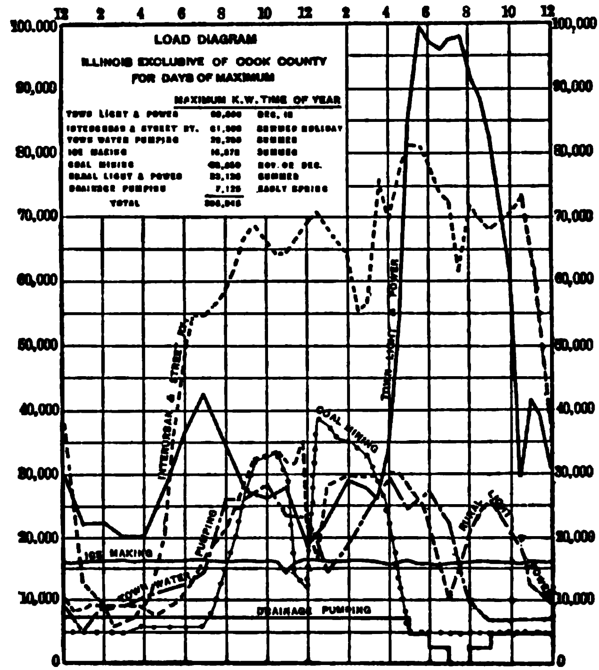


Fig. 17

year, which is the day on which you get the highest demand from all those businesses put together. With a separate generating and transmission system for each kind of supply, you have got to provide the investment necessary for that total of 305,000 kilowatts, so far as generation and primary distribution are concerned. What I mean by primary distribution is the transmission lines that go through the country to substations, which transmission lines are operated at relatively high pressure,

the pressure being reduced at the substations where the energy enters the local distribution system.

Fig. 18 tells the story, graphically, of the saving effected. The town light-and-power load comes about 5:30 on December 18th. The demand of the interurban and street railways, which is 81,500 kilowatts in the middle of summer, is down to

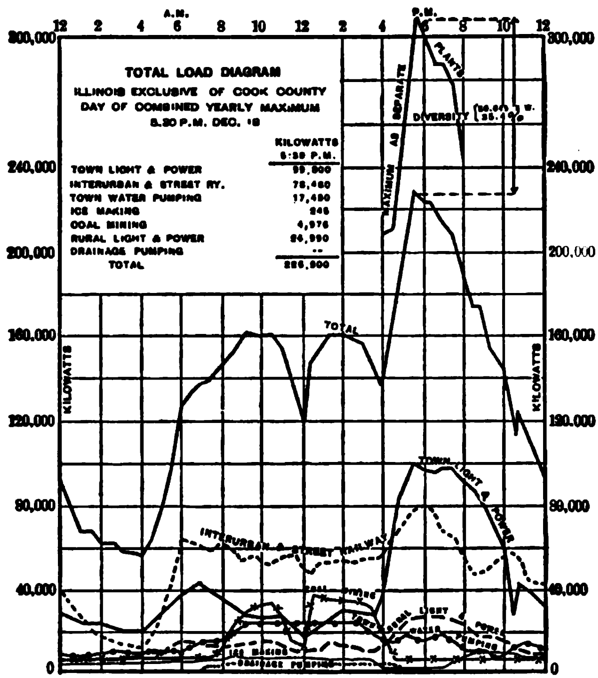


Fig. 18. Utilization of Diversity on a State-wide Scale

78,460 on December 18th. The town water and pumping is down from 29,290 kilowatts in the middle of summer to 17,430 kilowatts on the day of your maximum load. Ice-making goes down from 16,575 in the middle of summer to 245 in the middle of winter; coal mining from 38,530 at the time of its maximum demand for energy to 4,975 at the time of your maximum load in winter. The rural light-and-power load of 33,125 in the sum-

mer goes to 24,990 on the day of your maximum load. Drainage pumping load of 7,125 kilowatts in early spring is entirely off at the time of your maximum load in winter, and the 305,945 kilowatts of total demand, irrespective of the time when that demand comes, is reduced to an instantaneous demand of 225,900 kilowatts, or a difference of 80,045 kilowatts, or, to express it otherwise, a diversity of 35.4 per cent.

There is one set of figures that we have left out of these estimates. I refer to the amount of energy that would be required if the steam trunk-line roads of Illinois were electrified. I presume that when the time comes for electrification in the Central West it will follow somewhat the same course that is being followed in the East. The passenger terminals will probably be electrified first, because they seem to be the simplest to deal with. Then will follow the freight terminals, and it will probably be quite a number of years before we get to a point where steam electrification will take place generally. It will probably take place east of the Alleghenies long before it takes place in the Mississippi Valley, because of the density of travel and movement of freight, and owing to density of population, which is so much greater east of the Alleghenies than it is in the Mississippi Valley. But when the time comes, as surely it must come, for the electrification of the great arteries of travel of the country, the economical way for the railroads to get their energy will be to get it from these plants that, in my judgment, will be spread, by that time, all over the states, with their transmission lines gridironing the various states and carrying cheap energy to the smallest communities, thus changing entirely the basis of living, and giving less reason for great accumulations of population for manufacturing purposes in given centers because of the incentive of cheap power, which will not be confined to those centers, but will be available equally in small communities and in large communities. I very much doubt whether the conditions of load shown in the last two charts would be changed if all the steam railroads in Illinois were run electrically, except that the condition of diversity would probably be increased, and consequently the

condition of operation would probably be improved and the cost of energy would be reduced, even beyond any figures I can show you tonight.

TABLE IV.—SUMMARY FOR YEAR

	Kw. Hours		Maximum Kw.		Diversity		Load factor
	Amount	Per cent of total	For year	5:30 p.m. Dec. 18	Amount	Per cent	
Light and power......	238,717,500	24.9	99,800	99,800	.....	..	27.3%
Interurban and street railway............	334,996,600	34.8	81,500	78,460	3,040	..	47.0%
Water pumping.......	129,562,500	13.4	29,200	17,430	11,860	..	50.6%
Ice-making...........	62,126,300	6.5	16,575	245	16,330	..	42.7%
Coal mining..........	86,571,500	9.0	38,530	4,975	33,555	..	25.6%
Drainage pumping....	7,250,000	0.8	7,125	.....	7,125	..	11.6%
Farming.............	101,562,500	10.6	33,125	24,990	8,135	..	35.0%
Totals...........	960,786,900	100.0	305,945	225,900	80,045	35.4	35.9%

Load factor of combined systems 48.7%.

Table IV sums up in figures what you have seen on the diagrams. It would seem to indicate — and I am rather inclined to think it is a low estimate — that the total amount of energy that could be disposed of at this time for the purpose of light and power, interurban street railways, water pumping, ice-making, coal mining, drainage, and general farm purposes in the state of Illinois, outside of Chicago, is about 960,000,000 kilowatt-hours, or about one-fifth greater than the present output of the city of Chicago. The maximum load would be 225,000 kilowatts combined, as against 305,000 with them separated, or slightly less than the Chicago maximum.

The last column of Table IV shows you the load factor of all these businesses separately. The combined load factor of the entire system is 48.7, which is better than is obtained, so far as I am aware, in any large center of population in the world, and with an amount of output which, as I have stated, exceeds by one-fifth the largest output, so far as I am aware, in any large center of population in the world.

Table V shows the reserve capacities, etc. I have had these figures prepared to show you the enormous reserve that small plants, as a rule, carry in Illinois. In Northwestern Illinois they have 78.5 per cent reserve; in Central Illinois they have 82.9 per cent reserve, or with 69 towns and 182,000 popu-

lation and a maximum demand of 8,210 kilowatts they have a capacity of 14,600 kilowatts, being a reserve of 78 per cent. And yet the service under these circumstances is, as most of you know, very unreliable in small towns.

Table V.—Large Reserve Capacity

In Local Plants

	North-eastern Illinois	North-western Illinois	Central Illinois	Total
Number of towns for which information is available	6	16	47	69
Population	6,885	34,459	141,376	182,720
Maximum	415	1,897	5,898	8,210
Capacity	475	3,385	10,779	14,639
Per cent reserve	14.5	78.5	82.9	78.4

Table VI.—Estimated Saving in Plant Investment

	Maximum Kw. as separate systems	Estimated percentage reserve	Estimated requirement
Light and power	99,800	50%	149,700 kw.
Interurban and street railway	81,500	40%	114,100
Water pumping	29,290	50%	43,940
Ice-making	16,575	30%	21,550
Coal mining	38,530	50%	57,800
Drainage pumping	7,125	50%	10,690
Farming	35,125	20%	39,750
Totals	305,945	43%	437,530 kw.

Estimated requirement, 437,530 kilowatts at $100 per kilowatt	$43,753,000
Maximum kilowatts for above as combined system	225,900 kw.
Plus 20 per cent reserve	45,180
Total estimated requirement, for combined system	271,080 kw.
Estimated requirement, 271,080 kilowatts at $75 per kilowatt	$20,331,000
Estimated saving	$23,422,000

Table VI shows the estimated saving in plant investment. I have had this statement prepared, giving a comparison of the generating-plant cost for separate plants and for unified systems. The saving shown cannot be made except for new or

additional business, and as the old plants are displaced on account of wearing out. However, with the rapid growth of all these classes of business, this investment saving can be made in a few years, in addition to an enormous operating saving.

We are assuming that these plants with an estimated capacity of 437,530 kilowatts are put in as separate plants, costing $43,753,000.

The maximum kilowatts for the combined system would be 225,900. With 20 per cent reserve rating, which is ample, the total rating is 271,080 kilowatts, which at $75 per kilowatt is $20,331,000, showing an estimated saving of $23,422,000.

These figures are somewhat misleading to begin with. You could not handle that amount of business in the state of Illinois in small plants at $100 per kilowatt. The operating expenses of those small plants would be so great that it would be impossible to quote a price that would enable you to get the business, so that in a way you would say that would be an impossibility. It would be impossible to raise the money because you would be quite unable to make a showing with a series of separate plants. I do not know how many plants there would be, but they would run up into the hundreds. The only way to give cheap energy to a large rural community, whether it be to the manufacturing interests in those communities or for the necessities of the people, such as ice-making, or for mining of coal, or for the performance of public functions, such as water supply — the only possible way that it can be carried out is by concentrated production, which would call for the investment of $20,331,000 in stations.

To go into the matter of operating saving from that class of combination is almost beside the question, as that business can only be secured by a unified system of production having low investment cost in proportion to the load factor, and low operating cost in proportion to the load factor. To try to compare that with the costs of many little local plants, worthless in themselves except for supplying a few lines in their own various communities, would not be of any particular advantage to us in looking into this subject, because the

figures I would have to show would be, in a way, misleading, as I would have to assume that it would be possible to get the class and amount of business with the operation of small isolated plants that can only be obtained by a unified system of production.

Centralization versus Municipalization

The figures I have presented you show absolutely that the business in which I am engaged can be run — successfully run — only as a monopoly. To use the taxpayers' money in putting in a small lighting plant — in using the word "small" I speak relatively, meaning "small" as applied to towns with a population of 500 to 1000, and "small" as applied to a city of possibly one million or two million population, for what is small in one place would be relatively large in another place; but they are all equally small in total business obtained in any given center of population — to put the taxpayers' money into that class of investment, whether it is in a little Illinois village or a large city in New Jersey or New York, is simply a waste of money. While I do not wish to enter into a discussion of any controversial character in an assemblage of this kind, I do not know of any greater argument against the municipalization of the production of energy than the study of the economics of the business in which I am engaged. A study of such figures as those I have brought to your attention must lead any man of ordinary intelligence, not necessarily with technical experience, but any man with ordinary intelligence, to the conclusion that the only possible way to operate the business of energy production and distribution is by operating it as a monopoly in so much of the territory as you may want to serve from one organization. It does not necessarily follow that that organization shall cover the whole of a state or the whole of a county, provided the county is large enough for more than one utility. It does follow, however, that so far as any particular piece of territory is concerned, whether the energy produced be used for operating urban transportation, such as the surface lines and the underground lines and the elevated lines in a city like

Fig. 19. Map Showing Conditions Early in 1913

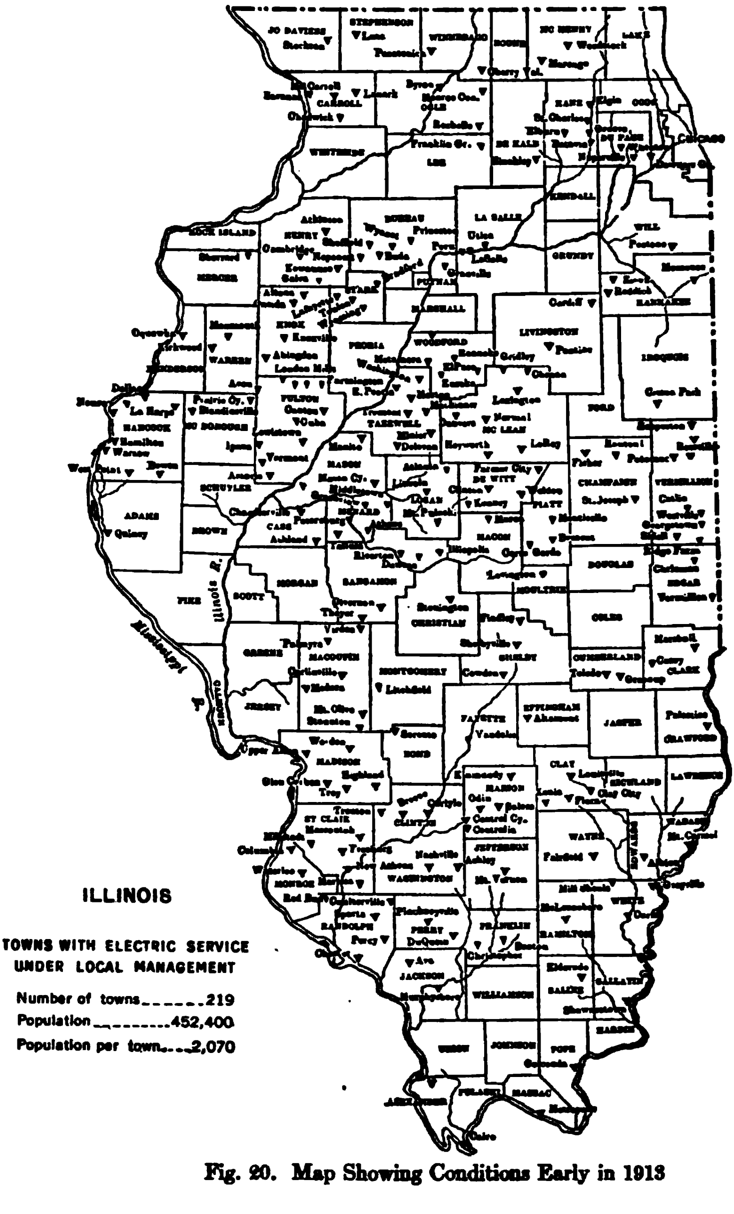


Fig. 20. Map Showing Conditions Early in 1913

Fig. 21. Map Showing Conditions Early in 1913

Philadelphia, or a portion of the terminal lines, or the main lines of the steam railroads centering in Philadelphia, or the lighting of your streets, or for supplying the thousand and one purposes that a community like this requires it for, such production and distribution of energy must, for reasons of economy, be a centralized one, whether such centralization be confined to the city or the county, or possibly covering a large portion of the state.

Let us consider for a moment the remaining maps and diagram, which may interest you.

Fig. 19 is a map of Illinois showing towns of over 500 population which are without electric service, and in addition there is the rural district that is not served at all. Fig. 20 is a map showing all of the towns in the state which have service from local plants owned and operated by local companies, and which, in a majority of cases, is only a six-hour or ten-hour service. There are 219 of these towns, of which 19 have a population of less than 500. Fig. 21 is a map showing all the towns in the state in which the electric service is owned and operated by some group utility, which service is being rapidly interconnected with and operated from the most economical available source of supply.

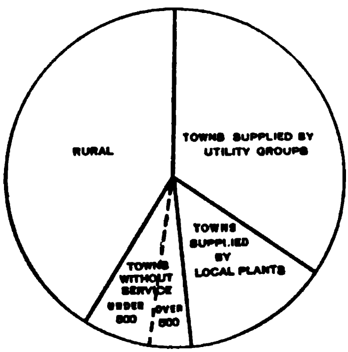


Fig. 22. Electric-Service Analysis of Illinois in 1912

Fig. 22 shows graphically the present electric service of the state of Illinois, exclusive of Cook County, analyzed according to population, showing that portion which has no electric service, that portion which has service from local plants, and that portion of the population which has service from some utility group. It brings out the fact that a little over half of this population is still without service. In statistical form the facts expressed in Fig. 22 are as follows:

	Towns	Population	Per cent of total
Supplied by utility groups	326	1,114,000	34.2
Supplied by local plants	219	452,400	13.8
Towns without service of over 500 population	180	119,200	3.6
Towns without service of under 500 population	1,713	216,300	6.5
Rural	....	1,366,100	41.8
Total	2,438	3,268,000	100.0

At this point I want to say that it would have been impossible for me to prepare any such statistics and curve sheets as I have shown you if I had not had at my command the devoted service of a large staff of statisticians, ably headed by Mr. Edwin J. Fowler, chief statistician of the Commonwealth Edison Company, and Mr. George E. McKana, assistant chief statistician. I think it is only fair that I should, in this public way, refer to the great service they have rendered me, and also the service rendered by the officers of the various companies which it is my privilege to operate, in the preparation of the data that I am using before you this evening.

What May Be Accomplished in Pennsylvania

But you people in this part of the country are a good deal more interested in Pennsylvania — that is, on this side of the Alleghenies — than you are in Illinois, which is some distance the other side. The figures I have given you are not merely theoretical figures; they are figures that have been prepared in connection with the operation of businesses employing a very large amount of capital, which businesses have been organized for exactly the purposes which we have set forth as hoping to accomplish in the diagrams shown this evening. We believe that every corner of this country where density of population justifies it must have in the next few years a general central-station supply of electrical energy for the general use of the people living in the small towns and the farming districts of the country. When I speak of density of population being a primary necessity, I probably exclude most of the territory lying west of, say, the center of the Mississippi Valley until you get across the Sierra Nevada Mountains and reach the wonderfully

productive territory of the Pacific Coast, extending practically from the Arctic Circle to the borders of Mexico.

In the territory east of the center of the Mississippi Valley it is not only possible, but it is practically certain, that we shall see in the next few years an opportunity to get cheap electrical energy alike in the country community and in the large city. Just see what that means for a state like Pennsylvania. You have the advantage of low cost of production from the large steam-generating plants of the two large cities of Philadelphia and Pittsburgh at practically opposite ends of this great state; you have a density of population of 171 per square mile, as compared with 101 in Illinois. If you eliminate cities of over 100,000 population, you have a density of 122 per square mile, as against 62 in Illinois. Or take your neighbor state, New Jersey, which has a density of population more than three times as great as that of Illinois, and if you will leave out the cities of over 100,000 population it has a density of almost four times that of the state of Illinois. So that what is possible for us on the other side of the Alleghenies is certainly equally possible for you people on the Atlantic seaboard.

To come back to Pennsylvania. Besides having the advantage of economical production at two ends of the state in very large centers of population, you have probably a million horse-power in water-power in the state. You have untold wealth in mines. I cannot see why it should not be cheaper to transport energy the short distance that it would have to be transported to some of the large centers of population in Pennsylvania than to spend the money in transporting coal on the railroad.

If it is possible to achieve anything like the cheap production of energy that a general unified system would bring about in the country districts, as comparable with the prices paid for energy in large centers of population, what a difference it would mean to our working population! The manufacturer has to go where he can get cheap raw material and where he can call on a large labor market. Still, there are many industries which can be developed in the center of a farming district,

where the farming population can be called upon to labor when they are not employed on the land. To my mind there is no more important factor in the great problems of life, the problem of how the workingman can get fresh air, the problem of how he can bring up his family in healthy localities, than the proper solving of the problem of the economical generation and distribution of energy for country districts.

I think it was Lord Macaulay who made the statement that "of all inventions, the alphabet and the printing press alone excepted, those inventions which abridge distance have done most for civilization." Lord Macaulay died before the opening of the electrical-energy era. I think if he were living today, he would have had in mind among the inventions which have abridged distance not only the telegraph and telephone, but he would add inventions that have enabled us to carry energy for the use of men at remote distances, in small towns and country districts.[1]

1. It may be of interest to mention here that in 1914 Mr. Insull founded the Franklin Medal, to be awarded from time to time by the Franklin Institute "to those workers in physical science or technology, without regard to country, whose efforts have, in the judgment of the Institute, done most to advance a knowledge of physical science or its applications." The medal is of gold and, besides suitable inscriptions, bears a medallion of Benjamin Franklin made from the portrait by Thomas Sully.

INFLUENCE OF ENGINEERING ON MODERN CIVILIZATION[1]

FRANCIS BACON, speaking three centuries ago, made this statement: "There are three things which make a nation great and prosperous — a fertile soil, busy workshops, and easy conveyance for man and goods from place to place." Half a century ago Lord Macaulay said, in effect: "The inventions which have bridged distance have done most for civilization." The work, or the inventions, of the engineers during the whole of the last century — the nineteenth century — and during the latter years of the eighteenth century were in the direction of bridging distance. If you take the fundamental working invention of the steam engine by James Watt in the latter end of the eighteenth century, you have one of the fundamental elements that led to such enormous mechanical developments during the whole of the nineteenth century. Another instance is the work of Robert Fulton in connection with the steamboat in the early part of the nineteenth century. Yet another instance is the work of George Stephenson, who engineered and operated the first real steam railroad ever constructed, the Stockton and Darlington Railroad in England, towards the end of the first quarter of the nineteenth century.

The introduction of gas, I think about 1815, was an important contribution by engineers to the development of modern civilization. Morse's work in connection with the electric telegraph in this country and the work of Cooke and Wheatstone in Great Britain, towards the end of the third decade of the nineteenth century, have probably, in conjunction with the development of the steam engine and the steam railroad, had

1. An address delivered at Urbana, Ill., on May 8, 1913, on the occasion of the dedication of the Transportation Building and the Locomotive and Mining Laboratories of the University of Illinois.

a greater effect on the development of civilization than almost any other contributions by engineers of the last century. This was followed up, soon after the middle of the last century, by the coupling of the two great English-speaking peoples by means of the submarine Atlantic cable. This achievement was one of the great factors that have led in more recent years to a better understanding between those two great peoples. From the time of the successful commercial establishment of the submarine cable to the discovery by Alexander Graham Bell of the principles underlying the commercial telephone of today was but a short period — I think but little over a decade. This was followed about the year 1879–1880 by the rapid development of the electric light and power industry and the general use of electrical energy. My first recollection of seeing an electric-lighted street goes back to London, where, about the end of 1878, the Thames Embankment was lighted by arc lamps, utilizing a Russian invention called Jablochkoff candles. While that exhibition was going on in Europe there were a number of able engineers and inventors engaged in the development of the electrical industry here in this country. Brush, Elihu Thomson, Edwin J. Houston, Edward Weston, George Westinghouse, Frank J. Sprague and many others represented the engineering intellect which was devoted to the development of electrical industry in this country, headed especially by the work and invention of Thomas A. Edison, who is entitled to the credit of devising the electrical distribution system as it is understood today.

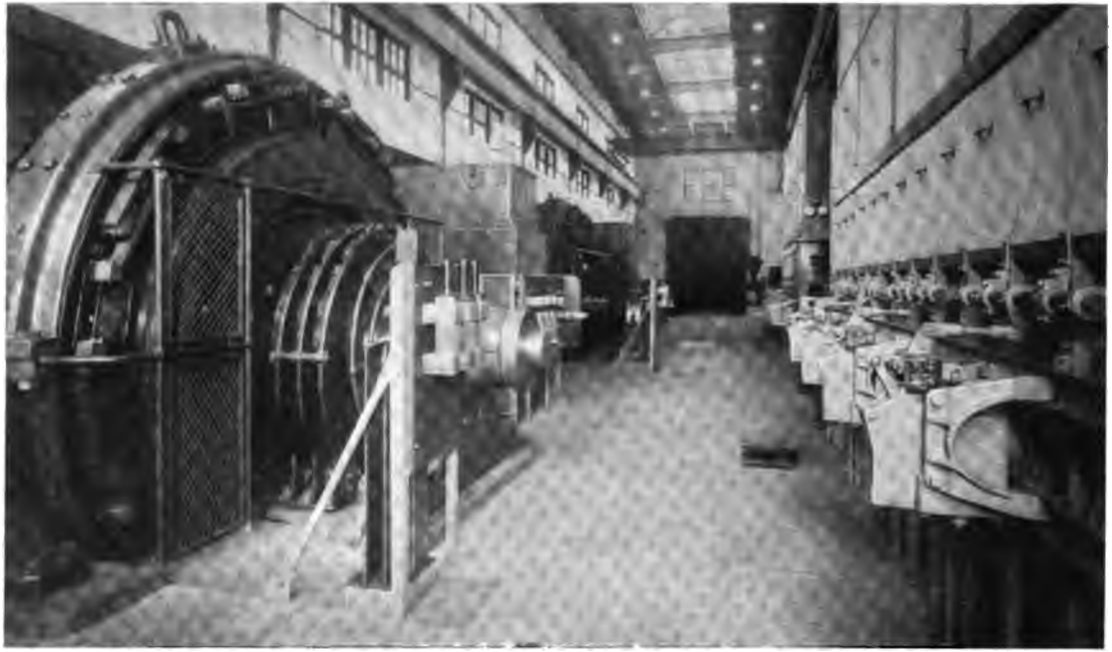
I have mentioned just a few names connected with engineering development; I might go on all evening in speaking of the personal work of various men; but time will not permit. There is just one other man, however, to whom it is fitting to refer — Mr. Marconi, whose marvelous invention of the wireless telegraph has practically annihilated space.

What Transportation Facilities Mean to Civilization

How have these great accomplishments of the world's inventors and engineers benefited civilization? Great systems

of transportation have been created ashore and great vessels afloat, connecting the several continents which border the great oceans of the globe. Surely an abridgment of distance, as Lord Macaulay put it, has been achieved by the work of these men. If "conveyance for man and goods from place to place" is one of the great elements in developing a people, surely the engineers who have contributed so much to the industrial development of the last century may be crowned as empire builders. The work of the great transportation agencies has made possible the great manufacturing establishments of Illinois, whose products far exceed the combined product of the agricultural and mining industries of the state. Their work has developed the manufacturing industries of the East by transporting the raw materials of the West and of the South. They have doubled in value the producing territory of the Mississippi Valley by bringing its farmers, and later its manufacturers, into touch with the markets of the world. The inhabitant, whether he be a trader or whether he be following any other occupation today — whether he lives in the Occident or the Orient — is alike under everlasting obligation to the engineers who have developed the great transportation systems ashore and afloat. Take the mere question of the abridgment of distance. London is today nearer to Urbana than Detroit was seventy-five or a hundred years ago. Pekin is today within easier reach of Champaign than New York was a comparatively short time back.

If distance has been bridged by the transportation engineers; if with their assistance and the courage and valor of the pioneers the forests and prairies have been turned into great producing farm lands, surely the telegraph and the telephone have produced an abridgment of time that would have seemed the impossible hope of the dreamer a hundred years ago. The telegraph and telephone, especially the telegraph, have made the world of nations next-door neighbors. The civilizing influence of contact, the impossibility of isolation, the knowledge of what is going on the world over and the change that such knowledge must produce in one's point of view, the effect of



Interior of Sedgwick Street Substation of Commonwealth Edison Company, Chicago

such knowledge on the development of our race, are all matters that must be traced more or less to the work of the investigator and the engineer in the invention and development of our great schemes of communication, either by telegraph or by telephone, local or international.

Cheap Electrical Energy for Rural Communities

The development of the business of the generation and distribution of electrical energy will probably have, within the next quarter of a century, very great influence on the development of our local communities, not alone the large cities but our rural communities throughout our states wherever there is any considerable density of population. Heretofore the business of producing and distributing electricity on an economical basis has been confined very largely to our large cities; but the marvelous works of our engineers during the last two decades — the great changes that have taken place in connection with the development of prime movers, the changes from the reciprocating engine to the steam turbine, the changes in use of units of 30,000 horse-power in place of units of 5,000 horse-power — are producing reductions in the cost of the energy which will lead to the centralization of production and distribution over wide areas in the interest of economy. This will be done in the interests of low cost to producer and low price to the consumer, and this centralization must have a very great effect in the development of the industrial interests of such states as Illinois. It is today not only a possibility but an actuality that the same advantages that we enjoy in large communities can also be enjoyed by the farmer, by the rural community, by people having large areas of land to drain and by others. The same privileges of low cost of energy can be obtained for them as are obtained for the users of energy in the large centers of population.

If you will trace back the development of the large manufacturing centers in this country, the early manufacturing centers, you will find that the workshop and the mill were established

where cheap power could be obtained. Until the last few years the only places where cheap power could be obtained were on streams where hydraulic development was possible. The great manufacturing establishments of New England owed their foundation largely to this cause. Suppose any very small community anywhere in the thickly populated territory of the Mississippi Valley is able to obtain energy for manufacturing purposes at low cost. Assuming that in that community the manufacturer can obtain the necessary labor; then it stands to reason that one of the great troubles of modern life will be solved by cheap energy.

Sociological Aspects of Cheap Energy in Rural Life

At the present time large manufacturing interests as a rule cluster around large centers of population. The reason for that is that power is relatively cheap where the manufacturers have a large population to draw on for labor. But as this state and other surrounding states become studded with manufacturing establishments the necessity which compels the workman to dwell in large centers of population, where living conditions are most unfavorable, will cease. He will be able to establish himself under conditions where he can get healthful environment for his family. Instead of living in overheated, ill-ventilated, small tenements of the big city he will have the opportunity to establish himself practically amid the desirable conditions that those living in the country ordinarily enjoy. Surely if this can be accomplished, if the living conditions of our people can be improved, if their children can be brought up under circumstances which will give them the foundation of good health, which will give them the opportunity of association in our country schools with that portion of the population — the farming population — which is the very backbone of the country, it is reasonable to expect greater satisfaction on the part of the workmen with their conditions and better relationship, because of a closer community of interests with employers, and, in general, a better chance for the workman and his family.

Modern Methods Make a Demand for Engineering Brains

It is natural in coming to the University of Illinois that I should want to address myself to the students of the College of Engineering, and to speak to them somewhat of the opportunities of their profession. The modern facilities for study — that is, the engineering courses as now known, whether for civil, mechanical, mining or electrical engineering, and the study of chemistry to be employed in the industrial arts — these facilities are most comprehensive and are a blessing to the youth of this great state. It often occurs to me to wonder whether the young men really appreciate the possibilities that are before them. It is not uncommon in this day, when big businesses and big combinations are receiving the attention of the politician and statesman, to decry the possibility of opportunity for the young man; but as a matter of fact there never was a time when opportunities were so great. The greater the business the greater the demand for trained men and the greater the reward for capacity, and for executive ability and training in special knowledge and ability. When manufacturing businesses or the great public-service businesses of the country were run on a small scale the item of overhead expense was one of the most serious that the manager had to deal with. From force of circumstances, the amount he could pay for trained brains was relatively small. But that condition does not exist with the modern methods of business development of large industrial establishments. Development of large transportation systems, development of large businesses of every sort, call for so much special knowledge and special training that the young men of our engineering colleges have today an opportunity that their predecessors never had.

The Empire Builders of the Future

In addition to one's duty to one's self to provide for the future, to take care of one's own, the young man of the common-

wealth owes a duty to the state in which he lives and to the community in which he resides. It is not necessary for him to enter public life in order to perform that duty. In private service he can get the personal satisfaction of work well done and of receiving the remuneration for work well done. Furthermore, there are many problems that the business man and the engineer will have to solve in connection with the development of the great businesses and the great industries of this country during the next two or three decades. Many of you young men, I suppose, think that there are no such opportunities in the transportation world as gave the chance for a James J. Hill or for an E. H. Harriman, but as the great transportation systems of this country develop there will be just as great an opportunity for the industrial empire-builders as there was for the grand old empire-builder who has done so much in connection with the development of the Northwest, or as there was for that other great builder, now dead, who did so much in connection with transcontinental travel and the development of the Pacific Coast.

I have about spoken my allotted time. If there is one word more that I may add, let me again appeal to the young men of this institution. There is no royal road to success. Achievement is only possible by very hard work. Whether your career is to be made as an engineer or as an agriculturalist or as a doctor or along chemical lines, the only way that you can get to the top is by the most strenuous labor; by forgetting the hours of the day and practically the days of the week. Constant hard work has brought success to many in the past, and there is no reason why the same task of constant and hard work should not bring success to all you young men and women who are attending this university.

POSSIBILITIES OF UNIFIED ELECTRICITY SUPPLY IN THE STATE OF ILLINOIS[1]

NOT SO very long ago if one visited any one of the principal cities of this country, and even many of the smaller cities of this country, he would find not one, but two, three, sometimes four, companies engaged in the electric-light-and-power business, competing with one another, on the mistaken theory on the part of those communities that by allowing competition, they were furnishing themselves with cheap energy. That method of doing business has very largely disappeared. There is little or no competition in the large cities in the business of the production and distribution of electrical energy.

Competition has been replaced by regulation. The communities have gradually learned, in many cases to their cost, that the paralleling of investments in the shape of generating stations and distribution systems simply added to the cost of the product which the community desired to purchase, and they have consequently come to the conclusion that a regulated monopoly, whether such monopoly be privately operated or publicly operated, is more in accordance with scientific methods than regulation by competition.

While the communities in which we operate have been learning something, we also have been learning something. It is but comparatively a few years ago that a company, even if it enjoyed the monopoly of business in the city in which it

1. Mr. Insull gave an illustrated talk in Chicago on May 15, 1913, before the Commonwealth Edison Company Section of the National Electric Light Association. He repeated, for the benefit of his own people, much of the material presented in the Franklin Institute lecture on "The Production and Distribution of Energy," given in Philadelphia in the preceding March. Some new points, or new ways of elucidating old principles, were brought out, however, and these are given in the present chapter.

operated, was in the habit, partly from lack of experience, partly from lack of apparatus, of establishing a series of central stations, none of which had any connection with any of the others. In fact, I well remember — it cannot be more than fifteen years ago — that one of the most distinguished engineers on the other side of the ocean stated that the only way to design an economical generating station and distribution system was to feed an area having a radius of from a quarter to a half a mile.

Learning Economics by Experience

Gradually as we obtained experience, as we profited by some of the experiments we tried, say ten to fifteen years ago, we came to the conclusion that the economical way to produce and distribute energy was to mass its production at a given point, convey energy by means of high-tension transmission lines to whatever subcenters of distribution we thought desirable, and then to distribute at possibly a lower pressure from those substations. We did not know, at the time that we started to do that kind of thing, much about diversity. We had learned something about load factors, but we had hardly dreamed of the savings to be gained by massing diversified uses or diversified territories, and we were practically stumbling along in the dark, but we found we got a little better results by the changed methods that we were pursuing.

In more recent years we have been inquiring into the economics of the situation. We have been trying to discover the economic laws governing our business. We have been trying to solve the question as to why we were able to obtain this or that result by pursuing this or that policy.

Most of the real information that we have on that subject has come to us within the last decade. First of all, as I have said, we massed production in large cities. Later on we tried it in suburban communities. Some people imagined we did this simply to get large amounts of turn-over, irrespective of the conditions under which that turn-over was produced. Others have imagined that we have done it so as to be able to

make the profits that follow financial transactions in the way of promotion. But the fact is that if the policies that have been pursued by the men engaged in operating this industry, whether in the large cities, in the smaller places, or in rural communities, had not been based on sound economic principles, they would have been bound to fail.

Estimated Electrical Requirements of the State of Illinois

It is estimated that if everything in Illinois requiring the application of mechanical energy were run electrically, about 1,350,000 kilowatts would be needed. The load factor would probably be about 53 per cent. The kilowatt-hours would amount to 6,336,355,000. The total estimated requirement for steam railroads is almost as much as the total requirements for all other purposes. According to the reports of the State Railway and Warehouse Commission, the coal consumption at the present time by the steam railroads of the state of Illinois is 11,620,000 tons. If the transportation business were operated electrically, assuming the coal consumption was three pounds per kilowatt-hour, there would be a saving of 7,500,000 tons of coal, or about 15 per cent of the total coal production of the state of Illinois. I do not know of any greater example of possible conservation of the resources of this great state than the gradual electrification of the steam railroads of the state.

What the London Times Said

It is sometimes pleasant to learn what people say about you when you are, so to speak, away from home and yet at home. In a London hotel on Wednesday morning, January 22, I was sitting reading a copy of the London *Times* containing an engineering review for the year 1912, when I came across this paragraph in reference to electrical development: "There was a pleasing note of optimism in the news that the Commonwealth Edison Company, of Chicago, which is probably the

most important electric-supply authority in the world, had placed an order with an English firm for a 25,000-kilowatt turbine-generator — the greatest power ever contemplated for a single shaft for any turbine or engine on shore or afloat." I took that as a great compliment for us all.

Sociological Aspects of Centralized Energy

It is probably not too bold a prediction to say that, within a relatively few years, the entire eastern part of the United States will be covered by a network of electrical transmission and distribution lines. Situated in that area at points where the greatest economy of production can be achieved will be large generating stations. The extent of territory that they serve will depend naturally upon the density of population of the immediate surrounding territory and the relation of cost of energy to interest charges on transmission lines, governed largely by the distance from the source of fuel, namely, coal, or the distance from hydro-electric plants, of which large numbers will undoubtedly be erected and prove economical when operated in connection with large distribution systems, with steam plants as reserves.

I myself am inclined to think, and I said this the last time I was addressing myself to this subject, that a great many of the problems of living, of labor, the bringing up of children under conditions where they can get the greatest chance to live and be educated and be surrounded with the proper environment — I think that those problems can be very largely solved by a wise system of production and distribution of energy extending over the rural communities in which we live, or rather which surround us.

Bearing on the Electrification of Railroads

I believe that the problem of the electrification of our steam railroads is going to find its solution when the density of travel is great enough to justify it in connection with this same mass-

A Boiler Room in the 1914 Extension to the Fisk Street Generating Station of the Commonwealth Edison Company, Chicago

ing of production. If at the same time energy is produced for the use of the small manufacturer, for the use of the mine owner, for the use of the rural community, for the use of the farmer; if at the same time energy is produced not only for the use of the interurban railroad but for the use of the great trunk-line systems of the country, the combined result will be such a low cost of production of energy as to make it desirable for a manufacturer to settle in any rural community where the quantity of labor justifies his building his factory.

I believe that at the same time many of the problems in connection with the enormous increase in expenses in the operation of our great systems of transportation will disappear. One of the most expensive things today in connection with operating a great railroad is the cost of handling freight at terminals where land is worth $40 a square foot. The cost of transporting freight through cities like Chicago, Cincinnati, St. Louis and the other important cities of the Central West is very high. One of the principal steam-railroad men in this community told me not later than this afternoon that it is a very common thing for a steam railroad to haul freight 500 miles for nothing, because all the money that the company received for hauling it was consumed in handling the freight and carrying it out of the city of Chicago.

What Cheap Energy Means

If anywhere along the lines of steam railroads the manufacturer can establish his factory, what better solution can you find for the handling of the freight problem? I have only to draw the attention of those who have traveled much on the Lake Shore Railroad to the enormous change in conditions that has occurred between South Bend and Elkhart, in Indiana, since the development of the water-powers on the St. Joseph River. It is a continuous city, almost, from South Bend along the railroad to Elkhart, whereas a few years ago it was nothing but farms. That is the result of cheap power.

Those of you who are familiar with the busy centers of

manufacturing in Connecticut, Rhode Island and Massachusetts realize the fact that it is cheap power that originally produced the concentration of manufacturing in that territory and that built up those great eastern enterprises.

If you go farther northwest and take the great flour-milling business established on the Mississippi River at St. Paul and Minneapolis, what do you find was the cause of the original establishment there of the mills? First, the material, the wheat of the Northwest, was close at hand, and, second, the cheap power of the waterfalls.

I think I am justified in saying that if you will allow the cost of distribution — I speak not only of the operating cost, but of the investment cost of distribution — the difference of cost of energy between that from a steam station and that from a hydro-electric station is of little or no consequence as long as we can get coal as cheap as we can get it here in this state of Illinois. I see no reason whatever, if the figures that I have presented to you tonight are correct (and my experience of the last ten years gives me absolute confidence in those figures as the basis for the financial operations that I have made in the last few years), why we should not carry cheap energy to the door of every home in this state of Illinois.

BROAD QUESTIONS OF PUBLIC POLICY[1]

THIS report is signed by Messrs. N. F. Brady, president of the New York Edison Company; Everett W. Burdett, general counsel of the Edison Electric Illuminating Company of Boston; H. M. Byllesby, head of the firm of H. M. Byllesby & Co.; Henry L. Doherty, head of the firm of Henry L. Doherty & Co.; Charles L. Edgar, president of the Edison Electric Illuminating Company of Boston; W. W. Freeman, ex-vice-president of the Edison Electric Illuminating Company of Brooklyn and at the present time connected with the Alabama Power Company; George H. Harries, president of the Louisville Gas and Electric Company; Joseph B. McCall, president of the Philadelphia Electric Company; Thomas E. Murray, vice-president of the New York Edison Company; Samuel Scovil, vice-president of the Cleveland Electric Illuminating Company; Charles A. Stone, head of the firm of Stone & Webster; Frank M. Tait, of the Dayton (Ohio) Power & Light Company; Arthur Williams, of the New York Edison Company, and myself.[2]

One of the reasons for making a practice of reading the report of our public policy committee at an open session during the time of the annual convention of the association is to acquaint our friends not directly connected with the great

1. As stated in the text, Mr. Insull has, for a number of years, presented the report of the public policy committee at the annual conventions of the National Electric Light Association. Usually the report is read at an evening session that is perhaps the culmination of the convention for dignity and impressiveness. Two of Mr. Insull's speeches on these occasions are given in this collection. The one herewith was delivered on June 4, 1913, at the Chicago convention. The other ("The Final Test of Welfare Work," page 193) was delivered at the New York convention of 1911.

2. A few of the gentlemen named occupy different positions now (1915) than at the date of this report.

industry with which most of you in this room are associated with the general trend of our policy on all public matters. It has been my privilege for a number of years to present this report, and to make some comments on it and to refer to some of the problems connected with our industry. The last occasion was a year ago, on the Pacific Slope, at the Seattle convention; and I then drew attention to the fact that the public policy committee of the association is composed of men who represent the larger financial interests connected with the electric-light-and-power industry.

Responsibilities of Managers of Utility Properties

Our president,[1] in his opening speech, stated that the probable cash investment in our business in this country amounts to about $2,500,000,000, and I presume that it is still fair to repeat the statement made by me at the Seattle convention of 1912 that the gentlemen who signed the report which I have just read to you represent and carry on their shoulders the responsibility that goes with upwards of one-half of that investment. So it is right to assume that men in that position, men who are responsible for from $1,000,000,000 to $1,250,000,000 of invested capital must feel the serious responsibilities that devolve upon them when they are considering the character of the report they shall put out, which, as I have stated, is practically the declaration of the association as to its policy on public affairs. I would especially draw your attention to the fact that the greater part of their report deals with such questions as employees' welfare, the minimum wage, safety and sanitation, and accident compensation.

In these latter days corporation managers, men who are responsible for hundreds of millions of dollars, are seldom given credit by the statesmen and politicians discussing corporate matters for taking any interest in the welfare of their employees, in the question as to whether these employees should receive

1. The president of the National Electric Light Association at that time was Mr. Frank M. Tait, of Dayton, Ohio.

a living wage, or in questions connected with the safety and sanitation of their establishments. And yet there is an enormous expenditure along these same lines going on from year to year, not only in the industry with which we are connected, but in other manufacturing industries. Take, for instance, the steel industry. In the year 1911 the United States Steel Corporation spent upwards of $2,000,000 in safety work and sanitation. It has about 200,000 employees, and therefore during the year it spent about $10 for each employee in looking after the health and general welfare of the men. The stockholders of the company got no dividends from these expenditures any more than our stockholders get dividends from such expenditures. The only dividends are physical, mental and moral health — very valuable assets in any community and in any country.

This great industry of ours, producing electrical energy, probably employs upwards of 200,000 men in the United States; and I do not think that an estimate of $2,000,000 a year spent on a similar class of work by ourselves at all overshoots the mark.

Government Ownership and Conservation of Resources

Some reference was made in the report to the question of municipal ownership. Most of you in this room have heard that subject discussed pro and con, again and again. The result of municipal ownership is usually, I would say almost universally, a waste of the taxpayers' money; so that apart from the interest we have in the subject, being engaged in a business subject to regulation and therefore subject to protection, we are all of us very largely interested in it from the point of view of the taxpayer. The public-service companies of almost every community have paid their fair share of the taxes. I am glad to say that there are very few of them who do not pay their fair share of the taxes; hence the public-service companies are very vitally interested in this question as taxpayers.

Fortunately, the wave that went over the country some

twenty years ago in connection with municipal ownership has spent itself; and if we will simply take the experience obtained during this interval in the operation of utilities of the character that we represent; if we simply take the experience of the various communities, the various municipal corporations, that have undertaken to operate these utilities, we can supply ourselves with all the figures and arguments necessary to demonstrate that the operation by a municipality of a public utility is not a necessary function of government, nor a part of the function of government.

When we met a year ago at Seattle, we heard a great deal about the subject of hydro-electric development on the Pacific Coast and on both sides of the Rocky Mountains, and we were given the point of view of our friends in the Pacific States as to the course now pursued by the Federal government with relation to the water-powers in the Forest Reserves. I think it was illuminating, the point of view that we reached there. We learned that there are large tracts in some of the great states bordering on the Pacific the development of which is absolutely stopped owing to the policy, or rather lack of business policy, on the part of the Federal government. Little or nothing has been done in the last year. Practically no advance has been made in the direction of getting a statement of policy from the Federal government — something that would initiate the development of the vast water-powers under government control on a basis that would give a fair return to capital invested. This subject, while not of very material consequence to those of us who live in the Mississippi Valley or in the states bordering on the Atlantic seaboard, is of vast consequence to those of our number who come from the two sides of the Rocky Mountains, and is one to which the public policy committee and the hydro-electric committee of the association should give most vigorous and close attention in the near future.

The Policy of Regulation

One of what may be called the trends of the times is in the direction of a closer regulation of our business by state com-

missions. Our business has always been regulated, either locally or else by the state, unless the state or municipality has chosen to neglect this power. There is one great advantage that must necessarily follow regulation, and that advantage is protection. Some of us are regulated by municipal authority, by boards of aldermen; and the only direction their regulation takes is regulation downward in price. Others work under state commissions that have given, some of them very satisfactory, others very unsatisfactory decisions; but take it altogether, by and large, the general tendency of state commissions has been satisfactory. As they have grown familiar with our business and have become educated in its requirements, their treatment of us has become more liberal. Speaking both personally and I think on behalf of practically all the members of the public policy committee, I would urge upon the members of this association to do whatever they can to bring about fair commission laws in the states in which they operate.

I first began to address myself to this subject when I was president of the association, now some fifteen years ago. At that time[1] I asserted that regulation must be followed by protection, and that regulation and protection naturally lead to monopoly. Ours is a business, as I will point out to you later, which can be run successfully only as a monopoly — successful, I mean, alike to the security holders and to the public. If we are to run our business permanently as a monopoly, the truly economic condition under which we should operate, we must be willing to have imposed upon us a fair amount of regulation, and that fair amount of regulation must necessarily be followed by a fair amount of protection. If we get the protection to which we are entitled, and which we must finally get as these commissions become educated in the intricacies of our business, the value of our securities will be greatly enhanced, the price that we must pay for money, which, after all, is the greatest item of expense with us, will be materially lowered;

1. Mr. Insull's presidential address to the National Electric Light Association in 1898 is printed in the present collection under the title "Standardization, Cost System of Rates, and Public Control," page 34 et seq.

and we shall be able, on account of an absence of raiding, on account of cheaper money, to make a fair return to our investors and at the same time give fair and reasonably low rates to our customers.

The Development of Electric Service in and near Chicago

Some of my friends have thought it might interest you if I refer somewhat to our business as we conduct it in this neighborhood. It is a very great pleasure to me to receive the members of this association in my home town. You will pardon the egotism if I say that I know there is a great deal to be seen here, in connection with the business of producing and distributing electrical energy, that should interest you, and from which most of you can draw profitable lessons. I do not mean to say that I can not get equally profitable lessons by visiting the communities in which you all operate; but here, in the city of Chicago, we have had the opportunity, partly from peculiar local conditions, partly from the characteristics of our people, but mainly from the courage of my financial associates, who have treated me so kindly over a period of twenty years — we have had the opportunity of solving, to a large extent, the question of the economical production and distribution of energy.

When I came to Chicago in 1892 the average size of our units of production was about 200 horse-power. At the present time the average size is nearer 20,000 horse-power, and within the next two years this size will be increased, so that our largest units will be 45,000 horse-power. We have been able to produce the conditions that justify the use of such large units of energy by a system of selling our product at the lowest possible price to the customer who uses it the greatest number of hours in the year. It is purely a question of averaging the interest account over the greatest number of hours, and consequently making interest charges the lowest possible sum per hour. That is all that is involved in the economical production and distribution of energy.

At the present time we have a rating of 425,000 horse-power. Last winter we had a load of 350,000 horse-power. We have machinery on order of 112,500 horse-power, so that by the time that machinery is installed our plant rating will be 537,500 horse-power. We are actually, at the present time, putting up, or else just getting ready to let contracts for, buildings that will house an additional rating of 285,000 horse-power, so that our present engineering scheme for the use of energy in a community of only about 2,500,000 people contemplates somewhere about 850,000 horse-power.

I think if your convention stays away from Chicago as long as it did this last time, that the chances are when you return we shall be up toward a million horse-power, or possibly started on the second million. We put out 800,000,000 kilowatt-hours in the year 1912. That is an amount of energy equal to the central-station production of any four cities of the United States outside of Chicago. I will not name any other cities; I would not want to embarrass my friends or embarrass myself in mentioning them. We burned 1,103,230 tons of coal last year. If the efficiency of our apparatus had been on the basis of the year 1902, just ten years previous, our coal consumption would have been 2,650,000 tons; so that I think we are probably among the biggest factors in the state of Illinois in connection with the conservation of the natural resources of the state. We sell our energy at an average price of a little over two cents a kilowatt-hour, and we produce it at an average price of a little over a cent, not figuring interest and depreciation.

The Massing of Production

These figures are mentioned with no idea of suggesting that all of our members can accomplish the same thing. All have not the same conditions. Vested interests have grown up, dealing with the production of energy in various communities, which it is difficult to dislodge. They are all of them in the larger cities doing a business so great that they do not need the encouragement that would come from knowing what we have

accomplished. I mention these figures for the advantage of our members who come from the smaller communities throughout the country. I refer especially to the communities in the more thickly settled portions of the country; to any portion of the United States between the center of the Mississippi Valley and the Atlantic seaboard, or to that portion of the Pacific Coast which is most densely populated and where the purchasing powers of the people is great because of the marvelous productiveness of their soil. I mention these figures for their encouragement. Relatively, they can attain the same results that we have done.

It is not necessary — it is an economic blunder — to have a generating station in every small community, irrespective of what other small communities are adjacent to it. The president of this association referred in his opening address to the tendency to change of ownership among the electric-light-and-power properties of the country, especially those in the smaller communities. Where that change of ownership, or the massing of ownership, has taken place among isolated properties, there is little advantage to be gained, except from centralized financing; but where that massing of energy takes place in a number of communities more or less close to one another, so that they can be joined up by a system of high-tension distribution, those combinations are following true economic laws, and if properly financed are bound to succeed. I know of no better way to fight municipal ownership or municipal operation in the small communities of the Central West than by adopting a system of centralization of production and distribution. It means low cost of the energy at the prime source of supply. It means the economical distribution of that energy over the territory served. It opens up possibilities of expansion in business to such an extent that if I gave expression to my real views on the subject I would be looked upon as a dreamer.

I often wish that I could see fifty years ahead, and be able to realize and enjoy the situation that will develop in connection with the great industry with which most of us are concerned. I should expect to see a vast distribution system stretching from

one end of the country to the other, wherever density of population justified it; to see electrical energy used for all classes of power, where power was required at all. By that time power will certainly be produced from a common source. There will be the closest co-operation between the man who produces his power from steam and the man who produces his power direct from water, a co-operation that will lead to a cost of energy so low as to place it within the reach of all, and make it possible to develop at almost any place almost any class of industry wherever transportation is provided and it is possible to get the operatives necessary for the manufacture.

PRESENT AND FUTURE DISTRIBUTION OF ELECTRICAL ENERGY[1]

IT IS a very great pleasure to me to be present at a meeting of this character, in this location, arranged mainly by the people interested in the incandescent-lamp business. Unless my friend Mr. E. W. Rice antedates me in the lamp business, I think I am the oldest lamp manufacturer in point of years on this island today. I think the first manufacturing cost sheet that I ever got out on the cost of lamps was for the month of March, 1881, thirty-two years ago. The cost of the lamps the first month, as I remember it, was about $1.50 to $1.75 apiece, and we were selling them for 35 cents apiece. It was not a very good commercial proposition at that time.

If my memory serves me rightly — if Mr. Morrison had been here he would have been able to assure me of the fact — I think that the first specimen of electrical transmission that I ever saw was the transmission line running from the old machine shop at Menlo Park, N. J., upon the hill, to a point about half a mile (maybe not as much as that, probably a quarter of a mile) east of the present Menlo Park station on the Pennsylvania Railroad. The building where the motor was installed was burned down some years ago. It housed the first commercial incandescent-lamp factory in this or any other country. I am inclined to think that a portion of the operations were effected by the utilization of a bipolar motor constructed on the lines of the old Edison design of bipolar dynamos, neces-

1. An address delivered on September 4, 1913, during the "Co-operation Conference" on Association Island (in Lake Ontario), N. Y. This island takes its name from, and is the summer rendezvous of, the National Electric Lamp Association. A number of electrical and business men of prominence were invited to attend the "Co-operation Conference" to discuss effective co-operation not only between the various branches of the electrical industry, but between producer and consumer as well.

sarily a direct-current machine at that time, the source of power being, as I have stated, in the machine shop on the hill. That is my impression; I know the motor ran there, and I know that a very few years ago that same motor was in use at the Harrison (N. J.) factory of the General Electric Company.

Electric Lighting to Become as a By-Product of the Electric-Service Business

I have been asked to speak to you on the question of the transmission of energy, which is an important subject, not alone to us but to everybody else in this great country. It is a serious question whether the economical production and transmission of energy is not a more important matter than the economical administration of the transportation systems of the country. If you will go back but relatively a few years and seek for the foundation of a number of the great manufacturing industries that are situated to the southward and to the eastward of us, you will find that long before there was any great unified system of transportation existing in this country the manufacturing interests represented today by enormous establishments were at that time situated very largely where they are today. Of necessity they were much smaller. They were usually situated on some New England stream where power could be developed cheaply. You see the remnants of those small water-powers even to this day. Some that have been abandoned by the manufacturers have been taken up in this generation by manufacturers of a different class of product, kilowatt-hours, and as you go along the marvelous roads of Vermont and New Hampshire and view the scenery in what may well be called the playground of America, you will often come across a small water-wheel with a single generator attached. If you will follow the leads running off from that machine you will find lines extending in every direction. Probably that water-power is the source of energy for ten, fifteen, twenty or thirty miles of transmission lines.

The business of the production of electrical energy started from the other end, not from a cheap source of power, but really from a very expensive source of power. Some thirty years ago the illustrious inventor whose name should be on every incandescent lamp produced in the world, simply in honor of the man who is entitled to the credit of founding the great industry with which we are connected (I refer to Mr. Edison) installed the first generating station and distribution system in the lower part of New York city. At that time the business of producing and distributing electrical energy was mainly for the purpose of producing light through the use of the incandescent lamp. The business of supply energy for motors was, so to speak, a by-product, just as much a by-product of the electric-lighting business of that day as coke and tar and ammonia are by-products of the gas business today. Notwithstanding the fact that the incandescent-lamp business has grown so that 100,000,000 lamps are consumed in this country in a year, the electric-lighting end of our business is destined to become, very largely, a by-product. That side of our business thirty, twenty, even ten, years ago was our main stand-by; it was the portion of our business from which we got the necessary income in order to pay a return to those investing their capital in our business. Although of such great importance as late as ten years ago, today, in looking to the future, I think that it is perfectly safe to say that the lighting end of the business will be the by-product side of the business, and I think the main income for a return on our investment will come from the power business.

Inevitable that All Energy Requirements of a Given Area Should be Supplied by One Organization

A few figures will show you what I have in mind. At the present time, in any real large central-station system where the entire energy requirements of the community outside of the isolated plants are supplied from one source — and that is the only economic way of supplying energy, as I shall endeavor to

show later on — the amount of energy used for incandescent lighting, as far as we are able to check it, is not more than 27 per cent of the total requirements under the best conditions. This figure may become 45 per cent of the total under conditions not so good.

The money figures are somewhat different. It is very difficult to get down to exact figures on the lighting side of the business, for the reason that many motor devices and miscellaneous appliances are on our lighting circuits, and the energy used by those devices is metered as electric lighting. Therefore, when the consumers' bills are rendered, they are rendered as lighting bills. But take the principal property that I myself have charge of — the Commonwealth Edison Company of Chicago — its income from lighting today, although it has more customers than any central-station company in the world,[1] is only 47 per cent of its total revenue. Its output for lighting is 25 per cent of its total output.

You will understand, therefore, why I take the position that our business is decidedly a power business rather than a lighting business, and that our function is to produce the energy that is required in a given territory, whether that energy is used for purposes of lighting, for purposes of stationary power, for industrial purposes, or for purposes of transportation. Just as inevitably as the sun rises and sets, so, to my mind, it is inevitable that eventually the production of energy for any given community or any given territory, whichever may be found to be the economic basis to operate on — the control of that production and the control of the distribution must be in the hands of one organization. If it cannot be done any other way — if that result cannot be obtained through the medium of private capital — I feel so strongly as to what must finally take place, that in my judgment it will become a public function. It rests largely with the people in this room as to whether it shall be done by private capital in this country, or whether it shall be done as a governmental operation.

1. See note to next chapter, "Electrical Securities," on page 437.

Low Load Factor Makes Lighting Business Alone Undesirable

If I were addressing an audience of laymen, I would probably trace the various conditions that had led up to this situation; but most of you people in this room are closely identified with one side or the other of the electric-light-and-power industry, either the manufacturing side of the business or the operating side; and if you will think but for a moment, you must agree with me that the development of the apparatus of largely the last ten years has led up to the situation such as I have described to you. It is the development of the rotary converter — its perfection as a piece of apparatus — and the development of the turbo-generator — those two things above everything else. To these might be added the improvements in construction and efficiency of static transformers. These three elements have led to the building of very large generating stations and the development of great distribution systems to carry away the energy produced at these stations.

It is only a few years ago, but a very few years ago, as time is measured, even in a man's lifetime, that the Chicago Edison Company spent a large sum of money in building a generating station on the South Branch of the Chicago River, at the bridge at West Harrison Street, known to most of you as the Harrison Street station. That station served its purpose, produced energy supposedly about as cheap as it could be produced at that time. Today that station is so little a factor in our business that I am free to say that I do not know whether it operates one month in the year or six months, and I think some years it does not operate at all. There is a property that cost between $1,500,000 and $2,000,000 and which has a little less than half the output rating of the last turbo-generator unit that we ordered for one of our modern stations. That about tells the story of the generating side of the business.

The ability to mass enormous production and to do it at an economy of cost, so far as investment and operating are concerned, with the permanency of building and installation which

it is impossible to attain with smaller enterprises, has brought us to a position where, anywhere this side of the Missouri River, where coal is reasonably cheap, energy can be produced at such low cost (it is not necessary to go into the figures here) that we are enabled to build an expensive distribution system and sell that energy at low cost not only in very large centers of population, but in the smaller towns and villages wherever the density of population justifies the expenditure on the distribution system.

What has led us to desert the electric-lighting business, so to speak, and go farther afield and turn our companies into power companies, energy-producing companies, offering to sell their energy for whatever uses the user may desire to put it to? Fundamentally it is the low load factor of the lighting business. The load factor of lighting of any city in this latitude is on the average about the poorest business that it is possible for an electric-light company to have. I would not have dared to make that statement ten or twelve years ago, even if I had known it. I don't think I did know it at that time; I was trying to persuade myself then that the lighting load was very good business to have. Today I believe in taking it because it is one of the obligations that we have incurred, and that, when taken in connection with other lines of business, can be made profitable. But, take it by itself, it is as poor a branch of business as any we take on our system.

Comparative Figures of Chicago Electric Service and Three Hundred British Stations

I think that is probably well illustrated by making a comparison between the figures of upwards of three hundred of the electric-supply companies in Great Britain and the figures of the Commonwealth Edison Company. We took the actual population of Chicago as 2,250,283 in 1912, or, to express it in round figures, we call it from two millions and a quarter to two millions and a half, and we compared that with the population of Great Britain in 1911 and 1912, of about 24,250,000. We

compared the Commonwealth Edison Company's business, in these figures that I am going to give you, with the combined business of 303 British electricity-supply undertakings. Their plant rating is 961,000 kilowatts; our plant rating at the same time was 264,000 kilowatts. Their output was 1,128,000,000 kilowatt-hours; our output was 712,000,000 kilowatt-hours. Their income was a little over $40,000,000, ours a little over $15,000,000. Their investment was $310,000,000; ours was $68,000,000. With approximately one and a half times our output, their investment was pretty nearly five times ours. Their business is largely lighting business; our business is a general business, but mainly power business. Now take the investment per capita as a test. They have an investment per capita of $12.78; we have an investment per capita of $31.24. But their kilowatt-hours sold per capita are 46.5 and our kilowatthours sold per capita are 326. In other words, we sell seven times more kilowatt-hours per capita than they do. Their income is $1.67 per capita and our income is $7.03. We have more than four times as much income per capita as they have. Their price, incidentally, is about 70 to 80 per cent higher than ours, notwithstanding the fact that we have expensive labor and they have cheap labor. They necessarily have cheaper money than we have, and, I think, lower taxes.

Now, these figures illustrate, no doubt, the difference between a general electric-service business and a mere electric-lighting business. I have not any very good information on their load factor, because they figure load factors rather differently from what we do. They figure load factor on the ratio of the average kilowatts sold to the maximum kilowatt capacity of their plants, and their load factor shows about 20 per cent. Our load factor shows 35 per cent on their basis of figuring. On the American basis I presume their load factor would show about 25 to 26 per cent and our load factor would show about 42 to 45 per cent. That I think about explains the story; that gives you about the difference between an operating company run for lighting purposes and an operating company run to supply energy for every purpose.

View in Fisk Street Generating Station of the Commonwealth Edison Company, Chicago. In the Foreground are the Two Horizontal Turbo-Generators (Rated at 20,000 and 25,000 Kilowatts) Installed in 1914

Engineers' Prejudice a Serious Obstacle

Let us consider what combination of production and distribution means. Take the average large company in this country. I mention especially the large companies, for the small companies have made greater advances in the direction of concentration of production and distribution than the large companies. If the average large company does just an ordinary lighting and an ordinary retail power business, its load factor is about 30 per cent. If it does a general business, quoting such rates as will give it a very large output of energy for manufacturing purposes, for transportation purposes, and for lighting purposes, its load factor will run about 45 per cent. In other words, the investment of the company will average to be in use 50 per cent more time than that of the company which runs its business on the basis of dealing in ordinary retail light and power. Increased load factor means a relative decrease in interest charge and almost a relative decrease in depreciation charge. The labor items are not of such serious consequence, although it would mean a partially relative decrease in labor charge, as labor is not in proportion to load factor.

What are the obstacles to producing a general system of generation and distribution which such figures would seem to indicate as desirable? The most serious obstacle, I think, is the question of the engineer. One gentleman explained it to me this morning as the engineer's caution. I told him I thought it was the engineer's prejudice. I think that is the most serious obstacle we have to deal with. To a lesser degree, and dealing with the lower grade of engineers, we have the same prejudice to deal with where we try to do away with the isolated plants that are among us. I would add to the obstacle of the engineer's prejudice another item — and I must ask those engineers who are in this room who are on that side of the business to excuse me for mentioning it — and that is the so-called self-interest of the consulting engineer. It cannot be the interest of the investor whom the engineer is supposed to advise, because it is easy of demonstration as to

which is the most economical course for that investor to pursue.

Such conditions grow up over a period of years. People are unconscious of losing any money and therefore they are perfectly willing to continue to lose money. But take the large energy-using enterprises of the country: it does not seem reasonable to suppose that the bankers who have provided the money would take the position that they do not want that money spent in the most economical way possible; that does not seem a reasonable proposition. It is easy of demonstration in any considerable amount of territory which carries over its area a considerable population that the economical course is to produce energy in large quantities. That is as simple a manufacturing proposition as producing lamps in large quantities. Then the energy should be distributed over as large an area as can be economically operated from one center.

But Prejudice Should Not Stand in the Way of Economical Operation

This is capable of demonstration not only from the point of view of the large cities but from the point of view of small communities. Take, for instance, the figures of the northern end of Illinois, with which I am personally familiar, not only statistically, but with the territory, because I live in it. Several years ago there were isolated central-station plants operated separately with load factors by themselves of 13, 14 and 15 per cent. Assuming the value of those particular plants, just the generating stations by themselves, at $175 to $180 a kilowatt, I can show you in that same territory, after building substations and transmission lines and increasing the investment per kilowatt over twice, that owing to the changed conditions — the permanence of the service, the low cost of the energy and the resulting increased power business — the load factor improved so that today it is practically 28 to 30 per cent. The business, from being just a little shoestring business which no one would care to give any particular attention to, grows

to formidable proportions, is easily finânced, and is put on a basis that is a credit alike to the owners and the users, and a great benefit to the territory that is served.

If you extend the business a little farther and take in the larger towns in the territory; if you go still farther south and embrace a large portion of the state, where they use energy for general transmission purposes, for interurban roads, for pumping water to drain the land in one place and to irrigate it in another place, for moving machines to cut the coal underground and produce the manufactured articles on the surface, a situation is produced where you have a load factor, owing to the diversity of the various businesses using the power, as large as you can get in any large city in this country.

These are not mere theoretical figures and conclusions. I am responsible for probably $250,000,000 invested in the business which is operated broadly on the policy that I have been trying to enunciate to you today. It is not a policy that is peculiarly my own. It is a scheme that has been worked out rather from the bottom than from the top. The week before last I traveled about 1200 miles by automobile through New Hampshire and Vermont, and I was surprised to see the number of small transmission systems operating through that territory. I was very much surprised to see to what an extent all the energy in a given territory was produced from one source. I had thought that we were doing more of this class of central-station work in the Central West, and especially in the Far West, where they have such large water-powers, and I was very agreeably surprised to see how much of it is being done in the old-fashioned East.

I see no reason why the prejudice of an engineer who desires to have the largest possible units in his company's generating station should stand in the way of the economical operation of the properties under his control. I see no reason why you should have a transmission system twenty or thirty feet above the ground, another one on the ground and another one twenty or thirty feet under the ground, and still a fourth one running parallel with that, each operating separately as is the case in

New York.[1] We fortunately live in a country where we have not reached the point of saturation, and where the possibilities of our business are tremendous. There is not any great difference between our business and the transportation proposition. You take any large city of the United States, and every new scheme of urban transportation that is laid out is practically filled and overflowing before it comes into use.

It is the same with our business. Before we can build a generating station we have the customers to absorb the energy that that station produces. A unification of the power generation and distribution in the large cities and in the country districts, especially in the manufacturing country districts, would have the effect of releasing a very large amount of capital temporarily. I do not mean to say that it is capital that would go into the bank; it would be very largely in the shape of copper. It would take but a few years for that to be absorbed by increased uses, and the service could be given cheaper. Or, if it is cheap enough now, and there is not a sufficient return being obtained on the investment, a greater return could be obtained from the investment.

The Future of Energy Distribution

I am expected to say something about the future of the distribution of energy. It is a little dangerous to predict what is likely to happen. I am absolutely positive that the necessity for the conservation of the fuel resources of this country will force the concentration of the production of energy. Tomorrow Mr. Vanderlip[2] is going to talk to you on the financial outlook, and I presume he will have something to say of the enormous sums of money required by the electrical business to finance it properly. I think, when you have listened to the figures which he must necessarily use, that you will come to the conclusion that the economical financing of this great busi-

1. Alluding to the elevated-railway, surface-railway, subway-railway and central-station electricity-supply distributions.

2. Mr. Frank A. Vanderlip, president of the National City Bank of New York.

ness in the future will force the concentration of the production and distribution of energy over such areas of our country as have great density of population.

It looks to me as if we are approaching an era when the business of producing and distributing energy will come into its own. You all know the vivifying effect on business of a given territory from the development of first-class transportation systems. Picture to yourself what must take place in this country, certainly east of the Mississippi River, from the development of general systems of energy distribution. To my mind this territory will be a network of lines for transporting electrical energy. And when that time comes, energy will be purchased as energy; it will be used for whatever purposes it may be required, such as in transportation, in the homes of our people, and in our manufacturing establishments. Our great trunk lines of transportation, certainly within fifty or sixty miles of their termini, will be purchasing that power to operate their trains. Electrical energy will perform the same functions for the whole community, whether in the great cities or in the hamlets and villages, that the small water-powers of New England perform for the small communities in which those water-powers were established.

There is another side of this matter that it is well for us to consider. While I suppose most of us engaged in this business are fascinated by its constructive possibilities, after one reaches a certain point one likes to feel that besides doing his duty to his associates and to those who entrust him with their money, he is contributing something to the progress of the country in which he lives and of the people among whom he has his abiding place. I think it is a great privilege to us in this business—of course I naturally refer especially to us on the operating side of it — that we are engaged in a business that has such great possibilities, not only of results to ourselves and our stockholders but in the great advantages that this business is capable of bringing to the people of this country, and the great part it must take in the future in the solution of some of the great industrial problems with which this country

is confronted. Providing that labor can be secured, I do not think it is at all a wild statement to say that in relatively few years there will be very few parts, certainly of the eastern states and the central western states, where energy cannot be bought at such prices as will enable a manufacturer to operate his plant economically, either in the smallest community or in the largest center of population. It is that point to which I am trying to work wherever I am operating, more especially in the great state of Illinois, which has been so kind to me for the last quarter of a century. My main reason for coming here is not to give you any new message, but to try to bring home to you the truths that come to me every day when I am running my business at home; namely, that there is only one possible way to develop this business to great permanent success, and that is on a basis of low cost of production, a minimum cost of distribution and a minimum selling price to the community.

ELECTRICAL SECURITIES[1]

WHEN I was asked to talk to you on the subject of electrical securities I was somewhat at a loss to know exactly what branch of that question to discuss before you. If I were talking to some of my friends — and I am glad to say that I think I count among my friends the investment bankers of this city — I should probably deal with the question of trust deeds and the desirability of making them as liberal as possible to the companies putting out the securities, and of the extreme necessity of that liberality in order to protect the borrower in time of stress. But as that branch of the subject is more or less of a controversial one, it occurred to me that what would probably interest you more would be to hear my point of view as to what should be the character of the property and the character of the operation of the property covered by a mortgage.

I do not mean that you should infer that my opinion is that as investment bankers you are alone interested in prior-lien securities. If those securities are to command high credit, they must have behind them junior securities conservatively issued bearing a close relation to the money invested in the property, to the gross income, and also to the net income of the property over and above the prior-lien charges. But, as your point of view is mainly that of the bond dealer, I shall not have much to say about junior securities.

There is no necessity of my trying to give you information as to what should be the character of the communities in which

1. An address, somewhat condensed, given on October 30, 1913, at the convention of the Investment Bankers' Association of America, held in the Blackstone Hotel, Chicago. It was during the progress of this speech that Mr. Insull gave utterance to the epigrammatic expression describing "a greater saturation of the dollar invested with the electrical energy produced."

these securities are issued and the necessity of having ample population, high purchasing power of the people in the territories served, or the necessity of having large industrial development to produce the necessary income to protect the securities. That subject you are far more familiar with than I am myself. My intention is to show you something of the operation of the electric-light-and-power business in this immediate territory.

The subject to my mind can be presented to the best advantage graphically, and I shall therefore show curve sheets and tables which will tell their own stories to a large extent and require relatively but little explanation from me.

Two Kinds of Engineering, and Their Value

Assuming that the property is there on which the securities are issued, and that the necessary money has been provided for the development of the business, the matter of real fundamental importance in connection with its operation is engineering.

There are two classes of engineering that we have to use in our business. There is the mechanical and electrical engineering, the engineering of construction, on the one side, and first-class selling engineering, the engineering that governs the getting of business, on the other side. Thus, it matters not how much money has been put into a property, or how conservatively the securities may have been issued, or how good is the prospect of business in the community, unless the engineering of construction is laid out on the most enlightened lines, good results will not follow. [Mr. Insull illustrated this statement by using the "conservation-of-coal" diagram, which, brought down later, is given in the next chapter, page 469.]

Having true engineering of construction as a basis, we come to another side of the business; that is, the engineering of selling. Fig. 1 shows that, starting in 1896 with a gross business of about $1,000,000, and increasing year by year, we had in 1912 a total business of $15,500,000, divided as follows: Light, a little over $8,000,000; power a little below $4,000,000, and the supply of energy for transportation purposes a little below $4,000,000.

It is interesting to note how closely the output figures (Fig. 2) follow the figures of money. Referring again to the curves of Fig. 1, you will notice that they follow very closely similar lines as shown on Fig. 2, so far as the total is concerned, but with a much sharper line so far as railways are concerned. The cause of the difference between those two curves, that is, the

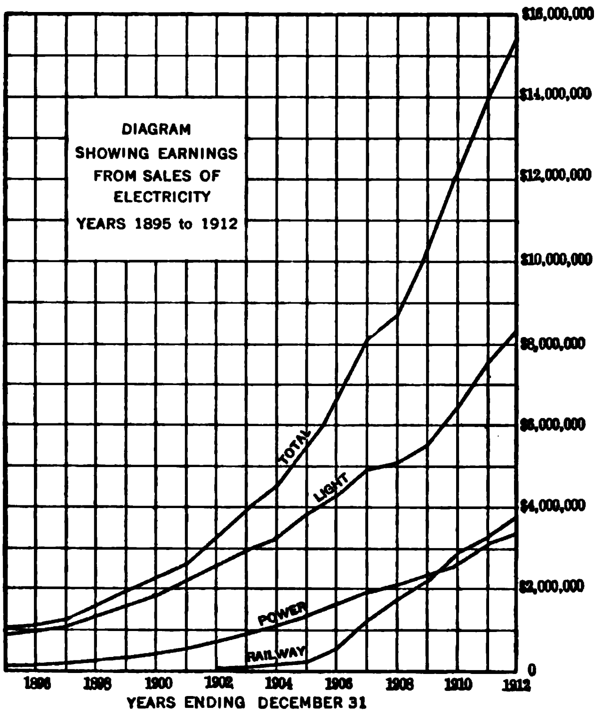


Fig. 1. Results in Chicago

money curve and the output curve, is the fact that in the development of our business we have probably carried to a greater extent than the majority of electric-service corporations the wholesaling of our energy, as is especially shown with relation to the output of energy for transportation.

This is illustrated again by this dollars-and-cents diagram (Fig. 3) with relation to income per kilowatt-hours sold.

The income from light shows a steady drop per unit sold from 1898 to 1912, amounting to about 40 per cent in price per

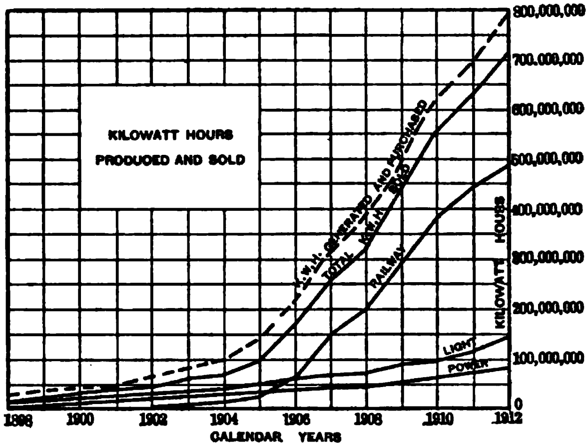


Fig. 2. Results in Chicago

kilowatt-hours sold. The power income follows somewhat the same curve. It started at a lower price and necessarily ends at a lower price. The wholesaling of energy for transportation purposes runs along on a very steady line. In the first

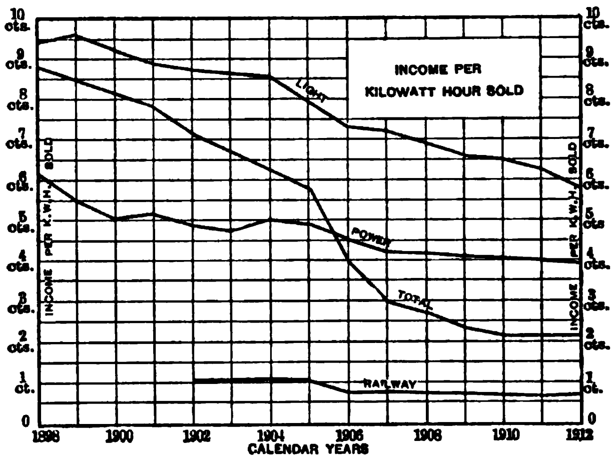


Fig. 3. Results in Chicago

three years the price did not vary. As the business developed the price dropped in 1906, and that price continues practically up to the present time and is on a basis lower than it is possible for the local transportation companies of this city to produce their energy themselves.

Fig. 4 shows another result of combining commercial engineering and the engineering of inventions. This diagram gives you the amount of electric light that could be bought for

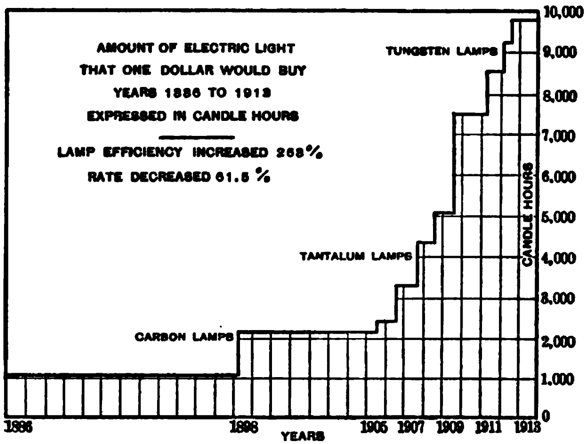


Fig. 4

one dollar in 1886, running absolutely even until 1898. Then the number of candle-hours was increased. Now, partly from the lowering of prices and partly from improvements in inventions, the lamp efficiency having increased 268 per cent and the rate having decreased 61.5 per cent, the amount of electric light that can be bought for one dollar has increased enormously.[1]

That to my mind shows the fundamental principles governing this great business and affecting the value of securities issued better than any curve that I can present to you. The improvement in efficiency is a tribute to the genius of the great inventors the world over, and the decrease in rate is a tribute to

1. See also Fig. 30 of the chapter on "A Quarter-Century Central-Station Anniversary Celebration in Chicago," page 327.

the ability of the selling engineers of the various corporations of this country. That curve would not vary very much in any large center of population in the United States.

The lowering of rates has been brought about by means of hearty co-operation on the part of the selling-engineering talent of all our great companies throughout the country. The improvement in lamp efficiency has taken place following the marvelous inventions of Mr. Edison, whose name stands at the head of our industry, and whose work has been supplemented by that of many other inventors, both in this country and on the other side of the ocean.

This question of commercial engineering has a very important bearing on a third important point, insofar as the character of the securities that you are dealing in is concerned. I refer to the relations with our customers and the relations with the communities in which the business is operated.

In Fig. 5 is shown the highest rates charged in forty-three large cities in the United States. They are for dwelling houses, stores, manufactories, all-night establishments and so on, and without any reference whatever as to whether the energy is produced from steam or from hydro-electric plants. The curves represent what the companies charge for energy without reference to the cost of the product. The second one shows the average of the forty-three large cities. The Chicago rates are shown in the third curve and the minimum rates of the forty-three large cities is shown in the lowest curve.

The branch of commercial engineering to which I have given particular attention during the last ten years is that of wholesaling energy in very large quantities. Backed by the courage of a body of investors who have stood behind me for upwards of twenty years in developing the business here in Chicago, ever ready to provide funds, so that starting with $1,000,000 we have got to a point where we have between $70,000,000 and $80,000,000 invested in the business, we have been able to try a great many experiments here in selling energy, some of which have been very much criticized. As a result we have been able to bid for classes of business not ordinarily

supposed to be handled by electric-light-and-power companies, who, as a rule, deal with retail business. What we are aiming at, and probably what everybody else is aiming at, is to get the greatest possible amount of output for the least possible amount of investment. One of the great difficulties in connection with the financing of the electric-light-and-power industry, and in connection with the sale of its product, is that it is impossible to store our product economically. In that respect we are

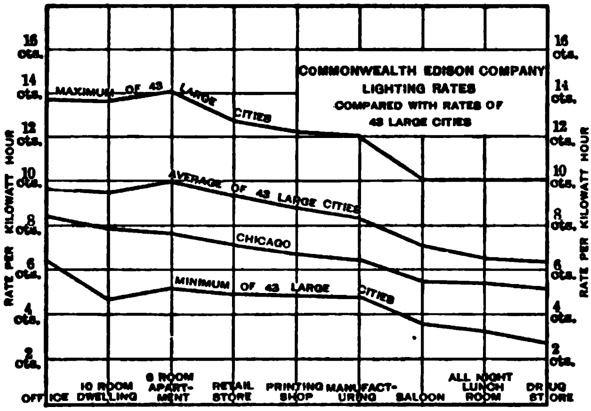


Fig. 5. A Comparison of 1913

at a decided disadvantage as compared with the generation and distribution of gas. As you all know we have to make our product at the same moment that it is sold, so that the problem before the commercial engineer, who is desirous of getting the greatest possible income out of his investment and to make the best possible showing for his securities at the lowest possible charge for energy, is to keep that investment working for as many hours of the day and days of the week as it is possible to do with due regard for safety of operation and permanency of service.

The great point that we all have to overcome is the maximum-load peak. We have to make the investment necessary to take care of that, and the problem before us is to fill up the valleys in the load curve. At the prices we get for energy in

this community, if we could not fill up the valleys to a large extent I doubt very much whether we could pay interest upon our funded debt, notwithstanding the fact that all of our junior securities are represented by cash invested to the amount of about $120 for every $100 of stock issued.

We started out to fill up the valleys more than is ordinarily done. By 1912 we had broadened the peak and partially filled up the valleys and had put ourselves in a position so that we were using our investment 31 per cent more of the time than we were using it in 1902. First-class commercial engineering is of primary importance in developing electrical industries. The advantage of using your investment 25 per cent more than the other man is able to use his investment makes the difference between ordinary earnings on the dollar invested and very favorable earnings on the dollar invested.[1]

Practically the greatest items of expense that we have to deal with are interest, and to a less extent depreciation, and these are the controlling influences with relation to rates. It is not the price of coal, nor the price of labor: it is the price of money that governs; and if you are only using that money 42 per cent of the time the cost of money per unit of output must be very materially greater than if you use that money 55 per cent of the time. To you as bankers that is a self-evident proposition.

I think, if I had to choose between first-class construction engineering and first-class selling engineering, inasmuch as the possibility of mistake is far greater in the selling side of the business than in the construction side of the business — if I had, as I say, to choose between the two I would choose first-class selling engineering, as it would give me more money on the dollar invested with which to make up for the mistakes made by the constructing engineer. Consequently, to my mind, the item of paramount importance to you is not the replacement value of the central station; it is not the replacement value of the electric-power-distribution system. The matter, to my

1. See curves in Fig. 14 of chapter on "The Relation of Central-Station Generation to Railroad Electrification," page 280.

mind, as an operating man, paramount in importance to you gentlemen is that the selling organization of the companies with which you deal should be of the highest possible order. And when dealing with the securities of public-service companies, you should see to it that their engineering methods are of the most enlightened nature, so far as the selling of their product is concerned.

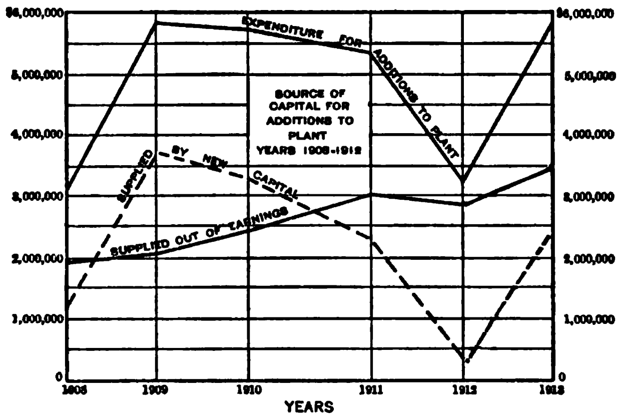


Fig. 6. Results in Chicago

Where the Capital Comes From

The curves in Fig. 6 give you some information as to where the capital comes from to increase the facilities of a large organization. It covers the period from 1908 to 1912, and, in part, 1913.[1] The dotted line shows the money supplied by new capital. The lower solid line shows the money supplied out of surplus, various reserve accounts, replacement accounts, depreciation accounts. And the upper line shows you the total expenditures for capital account over the period. It is not possible for all organizations to show that relationship. There are a good many first-class electricity-supply organizations in this country where the relation of new capital used to capital

1. Since the delivery of this address the diagram has been made complete for the years covered.

supplied out of the operation of the business is very much closer than in this case. I simply show this curve to give you an idea of what can be done in a large organization; to show you what a large proportion of money obtained from the operation of the business goes into the improvement of your security, namely, the investment in a plant and distribution system.

The tendency of that curve, if plotted for all the companies whose securities you gentlemen sell, or, certainly, for 90 per

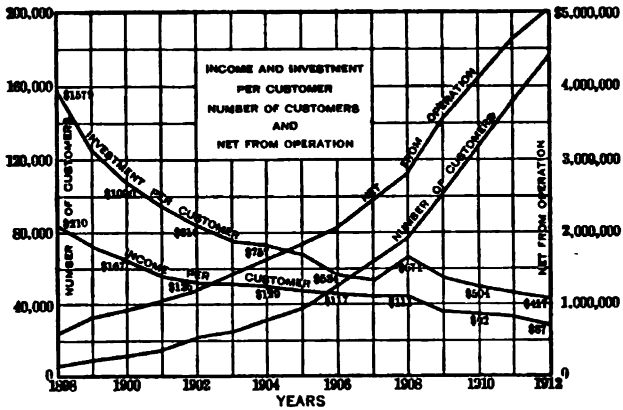


Fig. 7. Results in Chicago

cent of the companies whose securities you sell, while it might not show the same proportions, would be, in general, the same.

So far as I know, there is no branch of industrial work in which the tendency toward conservatism, so far as charging to capital is concerned, is so great as in the electric-light-and-power business of this country. This comes from a number of causes — partly from the effect of first-class engineering and partly from a greater realization on the part of people operating properties that their tendency should be toward greater care as to charges against investment account, with a realization of the great necessity for reserve accounts. This increased conservatism comes from a greater knowledge of the business on all sides of it.

I am dwelling on this subject of investment, or spending of money for investment in relation to the selling of the product, to an extent that you may probably think is somewhat irksome; but it is so important that I have tried to express this same thing in another way in the curves of Fig. 7. We start in 1898 with not much over 5,000 customers and end in 1912 with 180,000 customers.[1] In 1898 our investment per customer was $1,579, and our gross income per customer was $210. In 1912 that investment dropped to $417 per customer, and the income had

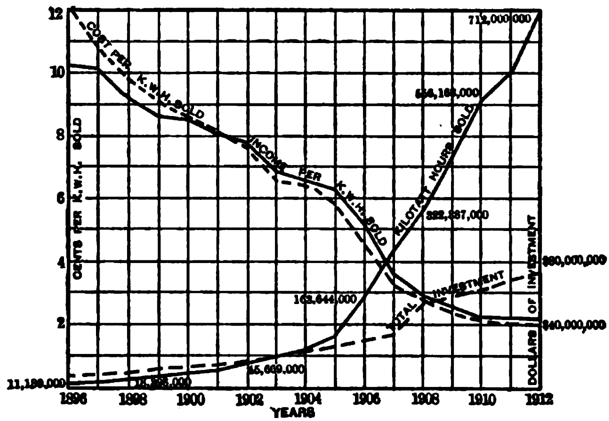


Fig. 8. Results in Chicago, Showing Relation of Cost to Income

dropped to $87 per customer. While steadily reducing our price and endeavoring to put ourselves in closer accord with our customers, we have at the same time produced a greater saturation of the dollar invested with the electrical energy produced and reduced the investment to $417 per customer. Improvement in that period shows that the relation of income to investment in 1898 was 13.33 per cent, and in 1912 was 21 per cent, with the necessarily accompanying result of a steady increase in net income from operation.

In Fig. 8 are other curves bearing on practically the same

1. The number of customers of the Commonwealth Edison Company on February 1, 1915, was about 254,000.

subject. They show that the cost of energy per kilowatt-hour sold in 1896 was about 12 cents per kilowatt-hour and our income was a little over 10 cents a kilowatt-hour, and yet we were paying our stockholders 8 per cent on their stock. There were two causes for this anomalous condition of affairs. At that time we made large profits from merchandizing electrical apparatus. The people in control of the management of the property at that time laid more stress on selling apparatus than on selling energy, and I am sorry to say I was at the head of the organization. That is one cause. Another cause is that in 1896, about a decade and a half ago, we knew so little about our business that we did not know how to figure our cost. If we had known how to figure our cost, we might have had greater anxiety as to the outcome. In Fig. 8 there is also a line showing the income per kilowatt-hours sold, and you will find extremely close relationship between the two curves of cost and selling price, illustrating the steady policy of reducing our rates. The "total-investment" line shows the growth of our investment from less than $8,000,000 up to about $80,000,000. Another line gives our output, starting at 11,000,000 and going up to 712,000,000 of kilowatt-hours sold.

You will notice that in the earlier period, when we knew far less about commercial engineering than we know today, the output and investment ran right along on parallel lines. It was less than ten years ago that we began to change. You will note in later years we have kilowatt-hours shooting up while total investment keeps on relatively even keel. That particular curve is very easily worked out for any large or small electricity-supply company, whether it be a lighting company or a power company or a diversity of both businesses, if records have been kept.

If I were judging of the character of securities, I would lay greater stress on the general information which can be obtained from such a curve sheet as to the business policy, the ability to sell the product properly, and the ability to get the best results out of the smallest amount of money invested. I would be more influenced by the general policy of the adminis-

tration of that business as shown by such a curve sheet than by almost any other information I could obtain.

As to the Scrapping of Small Plants

The figures I have given you so far relate to a large central power station and distribution system capable of supplying energy for a community of perhaps 2,500,000 population. The experience that we have obtained in this community of the relation of one class of business with another, and the advantages to be obtained from a great diversity of business, has led us farther afield. [The speaker then explained the possibilities of concentrating the energy supply for the power-using utilities (except trunk-line railroads) of the state of Illinois, outside of Cook County, as given in the Franklin Institute paper on "The Production and Distribution of Energy."]

Naturally, it may occur to the minds of some of you gentlemen that all these small plants exist; that they are all doing some business, and that if they are thrown away and large centralized plants are built to take their place, you are wiping out capital on which securities have been issued. Theoretically, that is correct. But the facts are these: There is scarcely a small community in the Central West where any business is done except street lighting and house-to-house lighting, and perhaps the pumping of the water locally. The cost of production is so high that these small plants cannot possibly sell energy for industrial or transportation purposes.

These plants must disappear. They are bound to be wiped out. The business of generating energy for use in the communities that they serve must be taken over by a large establishment, having economical apparatus in the form of generating plants connected with large distributing systems. It will then be possible, in these small communities, to distribute economically energy for transportation and manufacturing purposes. By that means the value of the investment in small local distribution systems will be increased by broadening the usefulness of these systems. This will help to preserve the

integrity of the securities that a great many of the investment bankers have taken on the small plants throughout the country.

It is the recognition of the economies of this principle of concentration which has led some of us to go farther afield in our business and not only deal with the large communities but also with smaller communities by uniting a number of small communities in one large distribution system fed by one or more generating plants.

This side of the business has other things to recommend it. As a rule, country plants are badly run, badly constructed; and their absorption by large systems means better service for the various communities served at lower prices, and consequently increased popularity on the part of the operating company.

The Financing of Holding Companies

The recognition of the great advantage of diversity of load has led to the establishment of large operating companies, some of them being holding companies with separate subsidiary operating companies. In speaking on this subject I am coming back to what I consider the interest of the investment banker in junior securities, just as much as it is of interest to the national banker or private banker to know what is the general credit and general standing of the individual he loans money to, even if in loaning that money he has ample collateral security for the loan made.

The great danger of the holding-company proposition is the issue of junior securities of subsidiary companies, these junior securities being sometimes put into collateral trusts of the holding company for the purpose of creating collateral for so-called prior-lien securities of the holding company. If the deed of trust underlying the collateral-trust securities is rigid enough to protect the purchaser of those securities against the creation of large floating debt in the operating company, and if the bond issue of the operating company is small and is a closed issue, there is no reason why the stocks of operating companies should not be put up as security for collateral-trust

bonds of holding companies. That is a side of electric financing which, to my mind, deserves the very serious thought of you investment bankers. The mere creation of so much paper does not add any more to the actual cash invested in the companies, and when you are considering electrical securities you ought to be fully informed as to the value of the property mortgaged, the relation of that value to the securities issued and to the gross and net income of the property. If the spread between the gross and net income is very great, you ought to look most carefully into the relation that the company issuing the securities holds towards its customers and the communities in which it operates with a view to finding out whether the company is exacting an excessive price for its product.

Bankers and Utility Men should not Oppose Regulation

A subject that has been referred to here to quite a large extent, as I judge from some of your committee reports, is the question of regulation — local regulation and state regulation of the public-service industry. Personally, I think that state regulation is the best thing that can possibly happen to this industry. Talking in another hotel in this city not far from this spot, in my presidential address[1] to the National Electric Light Association, on June 7, 1898, I stated that "Public control of charge for service, based on cost plus a reasonable profit, and eliminating the factor of competition, is the proper safeguard for the interests of users, taxpayers and investors." I am still of the same opinion. So far as I have seen, in almost every case where regulating commissions have been created, while there may have been isolated cases of injustice to one or another of the companies regulated, generally speaking the results obtained have been good for the industry, have been good for the securities, and have been good for the people of the communities in which we operate.

1. Reprinted in this collection under the title "Standardization, Cost System of Rates, and Public Control." The sentence quoted will be found on page 47.

I would venture to say, gentlemen, that in the principal cases where regulation has been apparently unfriendly to a property, if you could trace the management of that property, you would find that the people in control of it had not a proper appreciation of the underlying principles governing the business.

Take, for instance, the advantages to the company of regulation. I would very much rather operate under a low rate and know that that rate had the endorsement of some administrative state body, and know exactly where I stand, than to be harassed by, say, a board of aldermen, who are mainly governed by political considerations, whereas an administrative board, when it understands the business, if its members are honest men, gives us a fair return on the money we have invested, provided that money has been judiciously spent and provided that the business is judiciously run.

Stability of rates is one advantage we get from regulation, and regulation must necessarily be followed by protection against competition. The great economic waste of competition in a business which is naturally a monopoly must be brought home by the establishment of commissions or some other form of regulation on the part of our various states and as a result we are sure to get protection for our investment and consequently for our securities.

Probably I am a little liberal on this subject because my boyhood was spent in a country where rates of public service are regulated by the Board of Trade, where capital expenditures have to be authorized by Act of Parliament and where no public-service operation can be done without legislative action on the part of Parliament; and yet the securities of the properties so regulated stand very well in the communities in which they are established.

What is the advantage of regulation to the investor? After all, you gentlemen represent the investor. Regulation will prevent overcapitalization. It will prevent a lot of watered securities getting into the hands of the unsuspecting public — I do not mean through the agency of the members of the Investment Bankers' Association — but through the agency of an

entirely different class of security dealers. Protection against competition must necessarily add to the stability of the investment.

If you have steady rates based upon costs of service and no competition, and regulation of capitalization, you must of necessity have permanence of investment. My main message in speaking to the investment bankers of this country is to say that they and men in positions like myself make a very great mistake in opposing the fair regulation of an industry which can only be run as a monopoly; and no business should be run as a monopoly without a fair oversight on the part of the state.

[Mr. Insull displayed views of generating stations of the Commonwealth Edison Company before concluding. Some of the pictures are scattered through this book.]

Stability of Investment

Before I sit down I want to talk a little on the subject of stability of the investment. Many of you are engineers who in figuring replacement values must be fully aware of the very small amount of the investment that is really scrapped. I do not recall any case where scrapping on the part of first-class engineers has ever been more than 25 per cent of the value of the property; and in my judgment, taking the average of the properties today, that is a very large percentage. If you have a fair margin of investment to protect your prior-lien securities, the scrapping of a plant is of little or no consequence to you. Take the buildings that I have just shown you; they certainly have a life equal to a building of the character we are now in. Take the machinery. Boilers have not changed much in my day except that we get a higher efficiency out of them. Steam piping is relatively the same. If it is changed at all it is mostly a change as a result of bad engineering on the part of the operating company. Take labor and material. I have not discovered myself that labor is going down or that the items that go into the cost of building are reduced in price. Take copper and all the various elements that go into insulation.

The general tendency of values is up all the time, and consequently, from my point of view, gentlemen, you have little or nothing to fear from even such drastic scrapping as may necessarily take place in changing the electricity supply of a series of small communities to a central system, operating over a large area.

If reasonable protection is exercised in the establishment of reserve funds, and if above everything else the business is so run that the relation with the customers, and the relations with the community, are fairly cordial, I do not think you have anything to fear in taking the securities of the energy-supplying companies, certainly not those in the densely populated and productive portion of the United States.

CENTRALIZATION OF ENERGY SUPPLY[1]

THE SUBJECT on which it is my privilege to address you this evening is one which, under one title or another, it has been my pleasure to speak to in this city many times. The business in which I am engaged is essentially a monopoly business. At the outset I want it understood that I appear, not with any brief for monopoly, but to speak of the centralization of energy supply as necessarily a monopoly on purely economic grounds. It would be absurd for every householder to have his own water supply, his own gas-producing apparatus, his own method of disposition of sewage, a transportation system for his own use, or methods of communication by wire purely for his own use. These things would be no more absurd than it would be for the individual to have his own methods, his own apparatus, for his own individual use for the production of electrical energy.

The individual-supply idea is economically wrong. There is absolutely no good reason for it. The economics of the situation demand that the supply of energy, whether it be for use in private residences, for use in the store, for use by the manufacturer or for use by the transportation company, come from one central source. If the most economical results are to be obtained; if capital is to be conserved; if labor is to be conserved; if the prime source of power, whether it be the coal in the ground, or the waterfall tumbling down the mountainside,

1. An address delivered before the Finance Forum of the Young Men's Christian Association in New York on April 20, 1914. This body established a course of lectures in relation to public utilities. It invited the co-operation of men of prominence familiar with the financial, engineering, operating and manufacturing aspects of these utilities. The response was prompt and cordial. In accord with the purpose of diffusing knowledge on the subject, an advisory committee of New York business men interested in utilities assisted the Y. M. C. A. in its program. Mr. Insull's lecture was one of this course.

is to be conserved — in short, if we are to get the very best possible results alike for the user of the energy in low prices and for the producer in giving him a fair return on his capital, it is essential that the business of supplying that energy shall be centralized in one large organization for a given area.

So convinced am I of this fact — and I hope that my examples which will be shown to you this evening will convince you of the fact — that it would seem to me that in these days of regulation, in these days of preaching of economic operation of our various public services, the day will come when some of these great regulating bodies which are so absolutely necessary in a business which must naturally be a monopoly will question the waste of capital, the waste of fuel, and the waste of effort that goes on where the production of energy, instead of being centralized, is carried out on a basis of separate supply to separate classes of business and separate classes of users.

The Broad View versus the Narrow View

One great trouble in dealing with this subject is that it is usually viewed by those who discuss it from the point of their own particular interests; I might almost say from the point of view of their prejudice. They do not, usually, take a broad view of the subject; that is, as to what is best for the whole community; but they discuss it from the point of view of pride and satisfaction in the manufacture of energy in the particular generating station in which they are interested. Those of us who take, as we think, the broader view must overcome that prejudice, the prejudice of the engineer, the prejudice of great captains of industry, who, however well informed on the particular line of business to which they have devoted their lives, know little or nothing about the economics governing the production and distribution of electric energy.

There is another class of men who discuss the subject. I remember particularly a discussion of it within the last few months by a distinguished European engineer before one of

the learned societies of Europe.[1] This gentleman took up the subject with little or no knowledge of our conditions, unacquainted with the character of the service we supply, or the cost of that service, because of the various things demanded of us here that are not demanded in Europe. With little or no knowledge of the elements entering into our capitalization accounts, he came to the conclusion that the only method of handling the class of business about which we are to talk this evening is the method carried on in some European cities in which the corporations with which he is connected are mostly interested.

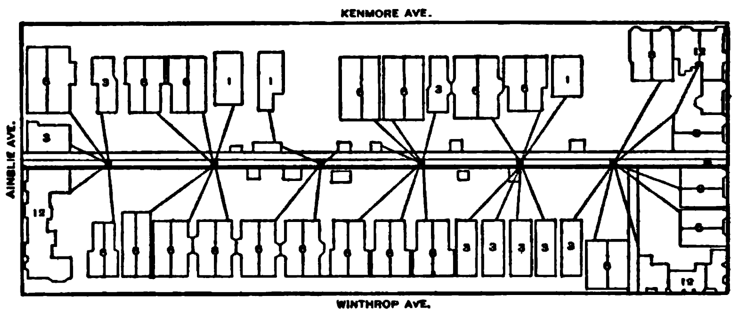
While I am naturally obliged to use to a greater or less extent the figures compiled by the statisticians of the company with which I am associated in Chicago, I hope to draw lessons from these figures that will show you that, on broad economic grounds, for the best interests of the community, whether that community be in a large city or in a small country town or village, or even in a rural district, this class of business should be run as a monopoly. As I have stated, it should be a regulated monopoly, for no public service, privately owned, and operated as a monopoly, should be unregulated. It should be conducted on the basis of one system of distribution and one central source of production. If this course is followed all through, the best results will be obtained for all, the greatest possible conservation of our natural products will be achieved, with a much reduced price for the product charged to the consumer, while the greatest possible profit, within reasonable limits, will be the reward of those who have the courage to put their money into the enterprise.

Diversity of Demand

Fig. 1 shows the diversity of demand. The fundamental

1. This refers to the paper on "Electricity Supply in Large Cities," presented by Professor G. Klingenberg, Ph.D., before the Institution of Electrical Engineers in London on December 4, 1913. Professor Klingenberg considered the conditions of electricity supply in London, Berlin and Chicago, and then went into a discussion of the factors, or supposed factors, entering into the cost of electrical energy in the cities named.

basis of profit making in public-service business is the diversity of demands. That is the difference between one human being and another, the desire of one human being to do one thing, and the desire of another human being to do something else, at the same time. I have used this particular chart a number of times, and so have a number of my assistants, to demonstrate this phase of the subject. The diagram represents a block of



Number of apartment customers	193
Number of hall-lighting and garage customers	34
Average number of lamps per customer	12
Kilowatt-hours used per year	49,620
Customers separate maxima	92 kw. = 6.3% load factor
Maximum at transformers	29 kw. = 20% load factor
Annual income per customer	$18.34
Diversity factor	3.2

Fig. 1. Electric Service for a Block of Apartment Buildings, Chicago, Illustrating Diversity of Demand

relatively small apartments in the northern part of Chicago, 193 apartments in all, and there are 227 meters in the block, being used by 193 apartment customers and 34 hall-lighting and garage customers. If you take each customer by himself, that is, each apartment by itself, the use of energy in each separate apartment is so slight that the investment to take care of that particular customer, if you trace it back to the generating station where the power is produced, would not be used on an average more than between six per cent and seven per cent of the time. But so varied are the ideas of human beings, and they so seldom do the same thing at exactly the same moment, that, if you take the whole 193 apartments together, and then

find out how much energy as a whole they use at one particular moment, the fact is developed that the diversity of their demand is so great that instead of using your investment only between six and seven per cent of the time, they use your investment, when taken as a whole, twenty per cent of the time.

If you will look around that neighborhood a little farther, you will find a number of local stores, motion-picture shows, and all the various types of small business establishments that go to make up a local community. When you add that business to the business of the apartments in the block, you find that you have increased the average demand on your investment in that particular neighborhood to such an extent that your investment is used thirty per cent of the time.

When you trace this load to the power station, you find that such is the combination of demands from several classes of business that these people in the residence territory call on you for the greatest amount of energy not when you require that energy to operate the office buildings and the elevators in these buildings, and the transportation system, and the stores and the workshops, but about two hours after all that work is practically closed down.

The whole question of the economics of the business of electrical energy supply is really summed up in the few remarks I have made on that particular chart, and the information which is given on the chart. The question of profit and loss, of the possibility of selling at one price or another, is all involved in that. It is a question of the diversity of the demand affecting the average use of your investment.

Fig. 2 gives similar information regarding an entirely different class of business, and it shows precisely the same thing. It has been only in the last year or so that it was possible to register the exact time at which a given consumption of energy takes place. We have tried in this particular chart to give you information as to the diversity of very large light-and-power customers as distinguished from very small light customers as shown in the previous chart.

The Chicago company of which I have the privilege of being

the head was the pioneer in installing in the early days a demand-recording meter called the Wright demand meter, and in working out, from a very large number of these customers, a tabulation on the relation of the maximum to the connected load for customers of various sizes and various classes. Those actual statistics have been used by many companies and organizations throughout this country in their rate-making schemes, which are based largely on the percentage of the connected load. The information given in Fig. 2 is the result of

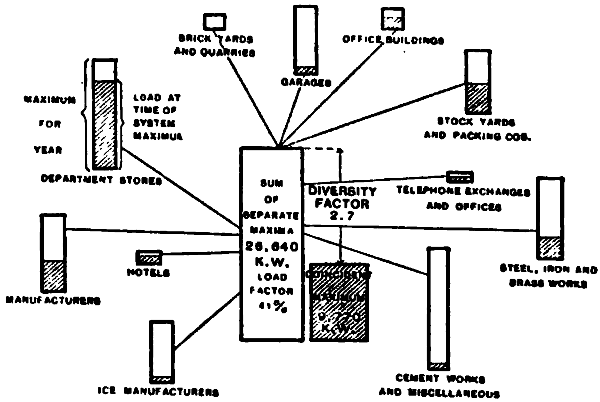


Fig. 2. Diversity of Requirements of Large Customers

exactly the same policy applied to our large or wholesale customers. We have been installing, as fast as practicable, metering devices which furnish us the tape record of the half-hour readings of the wattmeter of each of our large customers, and the tabulation shown on this chart is the result of a study of 82 such customers. From this tape record we are able to plot the 24-hour load diagrams and get the highest maximum for the year and also the load at the time of the total coincident maximum for the entire system, and thus arrive at the diversity.

I believe this is about the first information of this character that has been published. It is the first I have seen myself, and to those of you who are familiar with the business the mere showing of the chart explains itself, but for the benefit

of those who are not familiar with the subject I will give some detailed explanation.

Referring to the chart (Fig. 2), the highest rectangle in the center of the chart represents the total amount of energy called for by the 82 customers that are represented in these smaller blocks shown around the large block. The maximum load on our system came on the 6th day of January,[1] and the demand on us for energy, as I will show partly from this chart and partly from subsequent charts, was so diversified that notwith-

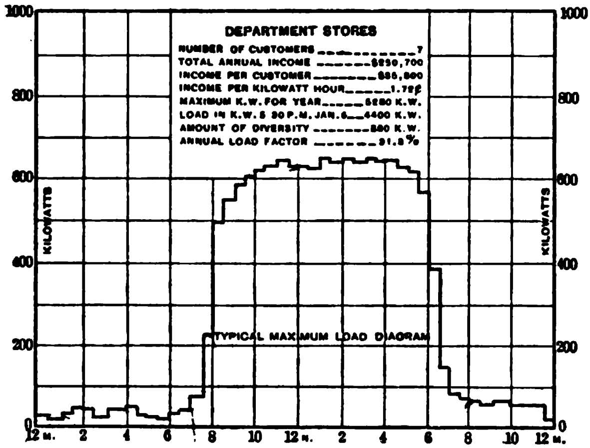


Fig. 3

standing it would have taken 26,640 kilowatts, or, roughly speaking, between 30,000 and 35,000 horse-power, to take care of the maximum demand of each one of these customers separately, on the day when the greatest demand came on us from all sources, it took only 9,770 kilowatts for these same customers. The difference between 26,640 kilowatts and 9,770 kilowatts represents what I have tried to explain to you as the diversity factor in our business.

That variation of demand, or diversity, comes about from a great variety of reasons. For example, the brick-yards and quarries, represented in the upper part of the diagram, do not

1. Speaking of the winter of 1913–1914.

run in the winter time, as the frost interferes with their business. The department stores represented by the block in the upper left-hand corner are particularly busy just before and just after Christmas, so that their demand is very high at that time. Referring to the block representing manufacturers, the workman cannot run a tool in a workshop — assuming the workshop is meant for light manufacturing purposes and located in a high building — he is unable to run a tool in the shop, go down in the elevator which takes him to the street,

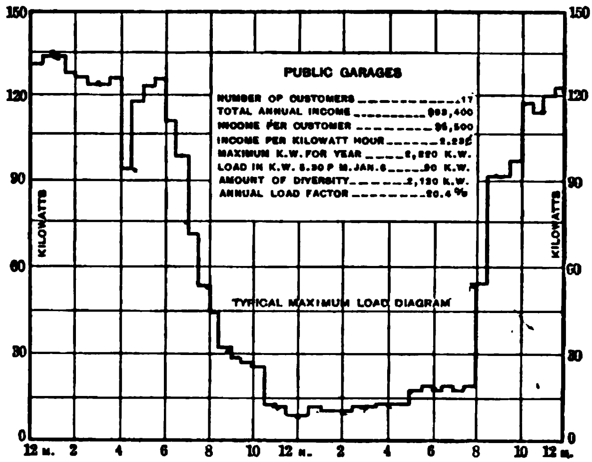


Fig. 4

travel on a street car, and use electric light in his home all at the same time. The maximum demand on the 6th of January came from all of these various sources, and you see that the manufacturer naturally shuts down before someone else is using the energy. Ice manufacturers do a relatively small business in zero weather. Therefore their demand is very light in the middle of winter. In the case of such heavy users of energy as cement works we make a special arrangement which provides that they shall shut off their demand at the period of our maximum load. In the case of steel, iron and brass works, their demand occurs before the period of maximum load on a

dark winter day, and so on with the other classes of business shown in the chart. The result is that the diversity is so great that what cannot be produced economically separately can be produced economically as a whole.

I am going to show you now in detail the various charts which represent the various businesses shown on the previous diagram. Fig. 3 represents the main department stores of Chicago. There are seven customers, seven department stores, the total annual income from which is $250,700, the average

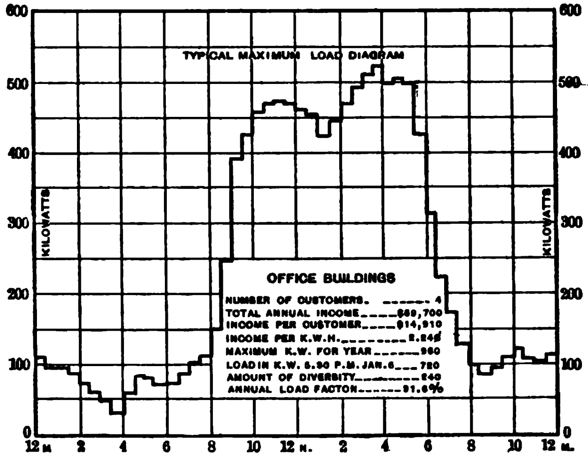


Fig. 5

income per customer being $35,800 per year. The income per kilowatt-hour, on account of the extraordinary character of the load and the large amount of energy bought, is 1.72 cents. The maximum kilowatts for the year amounts to 5,280. The load at the time of the maximum load on our system, January 6th, was 4,400 kilowatts, and the amount of diversity was 880 kilowatts. The annual load factor, that is, the average use of our investment for the separate customers, is 31.8 per cent. There are 130.8 acres of floor area in these department stores, and it cost about 4.4 cents per square foot per year for light and power.

Some 17 public garages contribute information to the diagram of Fig. 4. You will notice the income per kilowatt-hour is 2.23 cents. The maximum load in kilowatts for the year is 2,220, and at the time of our maximum load, on January 6th, it was only 90 kilowatts. These contracts are taken on the basis of our limited-hour or off-peak power rate, containing a provision that they shall shut off their service at the time of our maximum load. The amount of diversity involved in this service is very large, being 2,130 kilowatts, and

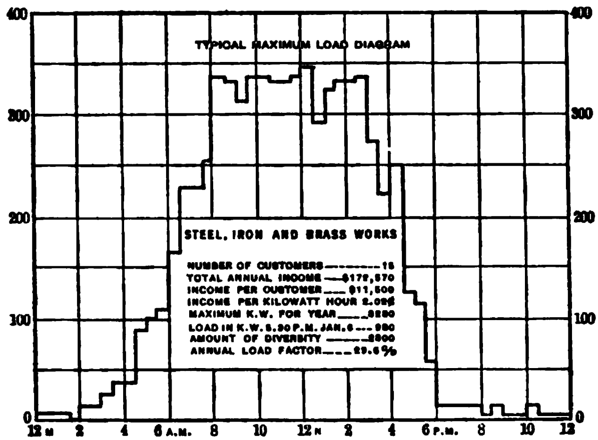


Fig. 6

the annual load factor is very low, being 20.4 per cent, but the business is very desirable because the demand for it comes at other than the times when our investment is needed to the greatest extent by the greater number of our customers. It is of interest to note that in the 17 garages mentioned there are 854 electric vehicles charged, at a cost per vehicle of $109 per year, or say somewhere about 30 cents a day for "feeding the horses," so to speak.

The ordinary office-building curve of Fig. 5 is not unlike a department-store curve. The especially interesting facts regarding office buildings are the load diagram, load factor and the diversity factor. Office buildings have always been

considered the least desirable class of business which it was possible for the central-station company to serve. This diagram and many others which we have studied show that at least a considerable portion of office-building business is about as desirable as most other classes of business, as the yearly load factor is very good, being 31.6 per cent. The reason for this, of course, is the all-day lighting on the lower floors and halls, and the elevator and other motor service.

The office buildings included in this inquiry have a floor

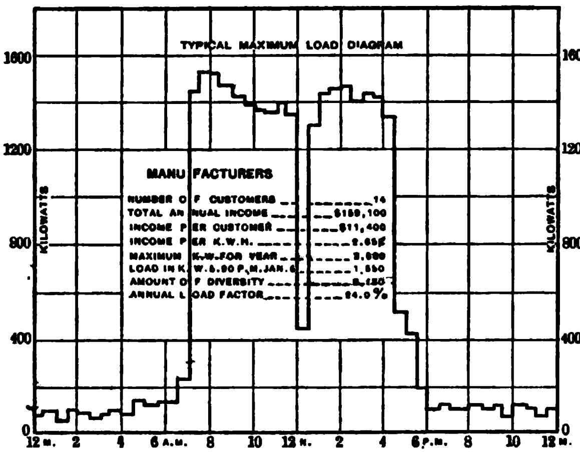


Fig. 7

area of 717,000 square feet and the cost of electricity for all purposes amount to 5.2 cents per square foot per year.

Fig. 6 represents steel, iron and brass works. If I had been asked, before we had the necessary instruments to indicate not only the amount of energy consumed but also the time at which it is consumed, whether that class of business was very desirable, because of its diversity, notwithstanding its low load factor, I think my inclination would have been to state that I very much doubted whether there was a large diversity. You will see, however, that the amount of diversity is 2,300 kilowatts, and the annual load factor is 29.6 per cent. I had the impression that such manufacturing establishments

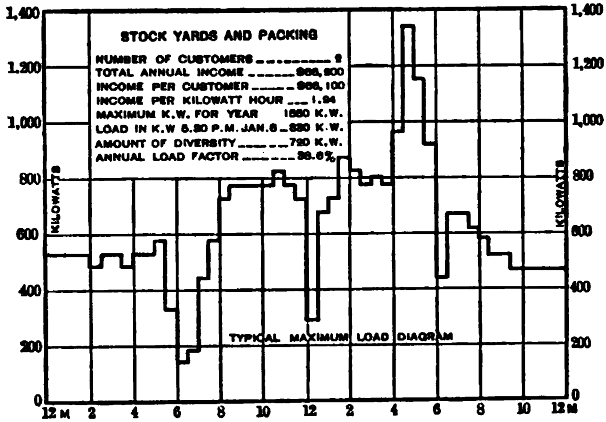

STOCK YARDS AND PACKING
NUMBER OF CUSTOMERS
TOTAL ANNUAL INCOME
INCOME PER CUSTOMER
INCOME PER KILOWATT HOUR
MAXIMUM K.W. FOR YEAR
LOAD IN K.W
AMOUNT OF DIVERSITY 720 K.W.
ANNUAL LOAD FACTOR
TYPICAL MAXIMUM LOAD DIAGRAM
KILOWATTS
KILOWATTS
1,400
1,200
1,000
800
600
400
200
0
12 M 2 4 6 8 10 12 2 4 6 8 10 12 M

Fig. 8

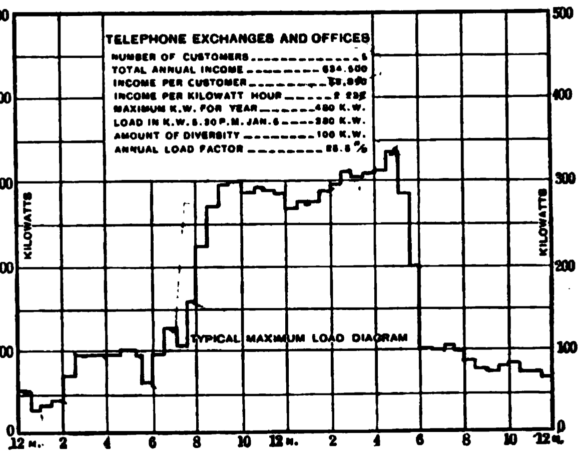

TELEPHONE EXCHANGES AND OFFICES
NUMBER OF CUSTOMERS
TOTAL ANNUAL INCOME
INCOME PER CUSTOMER
INCOME PER KILOWATT HOUR
MAXIMUM K.W. FOR YEAR
LOAD IN K.W.
AMOUNT OF DIVERSITY 100 K.W.
ANNUAL LOAD FACTOR
TYPICAL MAXIMUM LOAD DIAGRAM
KILOWATTS
KILOWATTS
500
400
300
200
100
0
12 M. 2 4 6 8 10 12 M. 2 4 6 8 10 12 M.

Fig. 9

probably demanded the greatest amount of energy from us at the same time that everybody else was demanding the greatest amount of energy. The contrary is the case. It simply shows to me — I do not know how it appears to the engineers who may be present — the extreme necessity of knowing all you possibly can about your own line of business. The diversity in that case is very great; it has a relation of 3,280 kilowatts to 980 kilowatts, and notwithstanding the low load factor, the value of it from every point of view is very great.

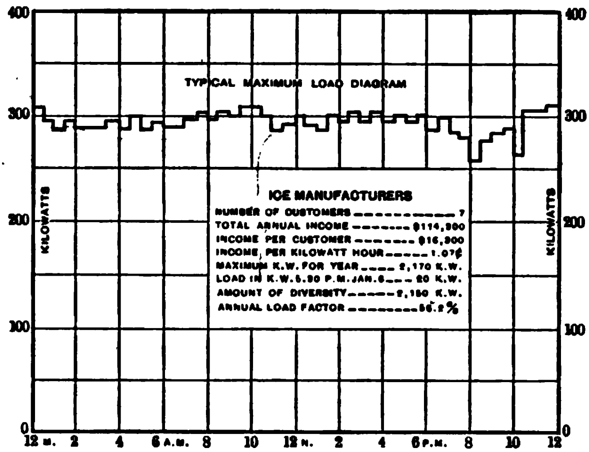


Fig. 10

A number of different classes of manufacturers are grouped, as to electric service, in Fig. 7. They are very much on the same general order as the steel, iron and brass works, and show a very decided diversity.

Fig. 8, relating to the stockyards and packing industries in Chicago, shows an entirely different class of business, but it displays good diversity and an extremely good load factor.

Electrical energy supplied to five telephone exchanges and offices is represented in Fig. 9. The cost of electricity per telephone customer or telephone connected amounts to about 28 cents per annum.

The load diagram of ice manufacturers is shown in Fig. 10.

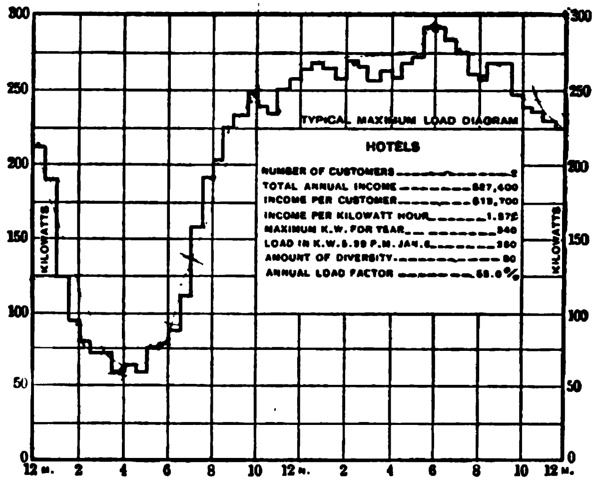

TYPICAL MAXIMUM LOAD DIAGRAM
HOTELS
NUMBER OF CUSTOMERS
TOTAL ANNUAL INCOME
INCOME PER CUSTOMER
INCOME PER KILOWATT HOUR
MAXIMUM K.W. FOR YEAR
AMOUNT OF DIVERSITY
ANNUAL LOAD FACTOR
KILOWATTS
KILOWATTS
300
250
200
150
100
50
0
12 M.
2
4
6
8
10
12 N.
2
4
6
8
10
12 M.

Fig. 11

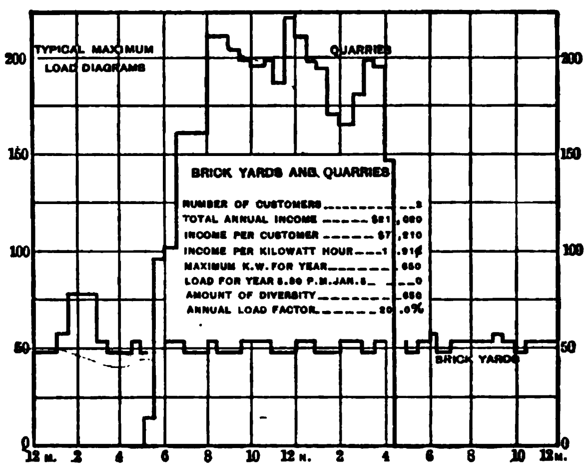

TYPICAL MAXIMUM LOAD DIAGRAMS
QUARRIES
BRICK YARDS AND QUARRIES
NUMBER OF CUSTOMERS
TOTAL ANNUAL INCOME
INCOME PER CUSTOMER
INCOME PER KILOWATT HOUR
MAXIMUM K.W. FOR YEAR
AMOUNT OF DIVERSITY
ANNUAL LOAD FACTOR
BRICK YARDS
200
150
100
50
0
12 M.
2
4
6
8
10
12 N.
2
4
6
8
10
12 M.

Fig. 12

The demand here is very satisfactory indeed, except that it is extremely low in the winter time. It practically goes off in the cold weather. The load factor is very high. The average annual load factor is 56.2 per cent, and at the time when the maximum demand is made on us for energy — the time when our plant is taxed to the utmost — the amount of energy used in ice manufacturing is only one per cent of the maximum demand for the year in this class of business.

The same class of information with relation to hotels is

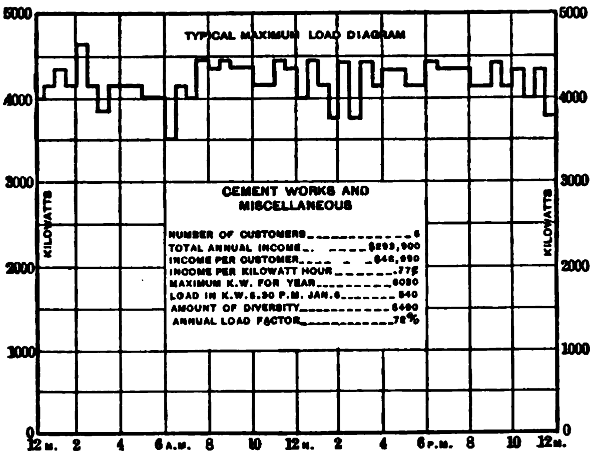


Fig. 13

shown in Fig. 11. The load factor is very good, but the diversity is relatively poor as compared with some of the other businesses.

Energy consumption by brick-yards and quarries is shown in Fig 12. As I stated before, these industries are discontinued in the winter time.

Another class of business, cement works, as well as miscellaneous operations which use a large amount of energy, present the load diagram of Fig. 13. Here there is great diversity between the maximum demand of the load of this class of business and the demand at the period of our maximum load of our entire business.

Table I gives the summation of the figures given in Figs. 3 to 13 inclusive. It is a good indication of the average power business in any large city. But, as I have stated, there are

TABLE I.—SUMMARY OF LARGE LIGHT-AND-POWER CUSTOMERS WITH PRINTING-TAPE WATTMETERS

No. of customers	Kind of business	Annual income		Maximum kw.		Diversity	Load factor
		Amount	Per Kw.-hr.	For year	5:00 p.m. Jan. 6		
7	Department Stores......	$250,700	1.72c	5,280	4,400	880	31.8%
17	Garages................	93,400	2.23c	2,220	90	2,130	20.4%
4	Office Buildings.........	59,700	2.24c	960	720	240	31.6%
15	Steel, Iron and Brass Works..............	172,600	2.02c	3,280	980	2,300	29.6%
14	Manufacturers..........	159,000	2.05c	3,680	1,550	2,130	24.0%
2	Stockyards and Packing	66,200	1.24c	1,550	830	720	39.2%
5	Telephone Exchange and Offices..............	34,500	2.23c	480	380	100	35.6%
7	Ice Manufacturers.......	114,300	1.07c	2,170	20	2,150	56.2%
2	Hotels.................	27,400	1.67c	340	260	80	55.0%
3	Brick-Yards and Quarries	21,600	1.91c	650	....	650	20.0%
6	Cement Works and Miscellaneous...........	293,900	0.77c	6,030	540	5,490	72.0%
82		$1,293,300	1.35c	26,640	9,770	16,870	41.2%

Diversity Factor... 2.7
Total Kw.-hr. sold..96,077,500

only 82 customers included in this and the previous charts on that subject. We have about 428 other large customers, who give us about $1,500,000 of income a year, so that the power business of that character yields us somewhere between $2,500,000 and $3,000,000.

We are applying the same method of measuring, as rapidly as possible, to all our large power customers. Eventually we hope to have elaborate tabulations which will show us the advantage of one class of business as against another, with the relation of the prices charged to earning capacity from our point of view of each separate kind of business.

TABLE II.—ANNUAL INCOME FROM SALE OF ELECTRICITY

	Per capita	Per Kw.-hr.
Baltimore..................................	$4.22	2.72c
Philadelphia................................	4.65	3.67c
New York and Brooklyn......................	6.37	4.45c
San Francisco and Vicinity....................	6.40	1.97c
Boston (City and Suburbs)....................	6.48	5.37c
Chicago....................................	7.18	2.05c

Table II shows two interesting features in connection with the production and distribution of large amounts of

energy. These are the sales per capita and the price per kilowatt-hour. There is some question as to the extent to which per capita figures are any real guide to conditions, but the fact is that it is almost the invariable rule that where you have a low price per kilowatt-hour you have a high income per capita. Boston, with its high income per capita, is an exception, as is

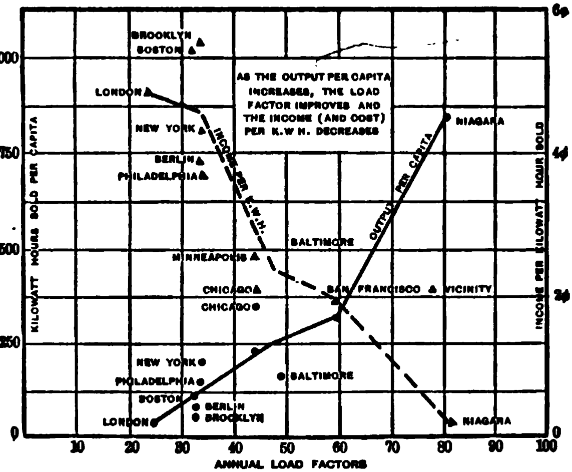


Fig. 14. Relation of Income to Output

also Baltimore with a low income per capita owing to its large colored population. I happen to have the figures as regards gas consumption (Table III), and it is rather interesting to find that, although the electrical business is a comparatively new

TABLE III.—ANNUAL INCOME FROM SALE OF GAS
(Exclusive of Street Lighting)

	Per capita
Baltimore	$6.17
Philadelphia	6.21
Brooklyn	6.31
Chicago	7.13

one, we have in Chicago already managed to pass the sales per capita of our friends in the gas business. The income from the sales of gas per capita is $7.13, and the income from the sales of electricity per capita is $7.18.

Fig. 14 shows that as the output per capita increases, the load factor improves and the income (and cost) per kilowatt-

hour decrease. For instance, the income per kilowatt is very high in London, England, the output per capita is very low, and the load factor is relatively poor. If I had on this chart a cross curve which would follow practically the line of income per kilowatt-hour, that is, figuring cost as the total of labor-and-material cost, interest and depreciation, you would see

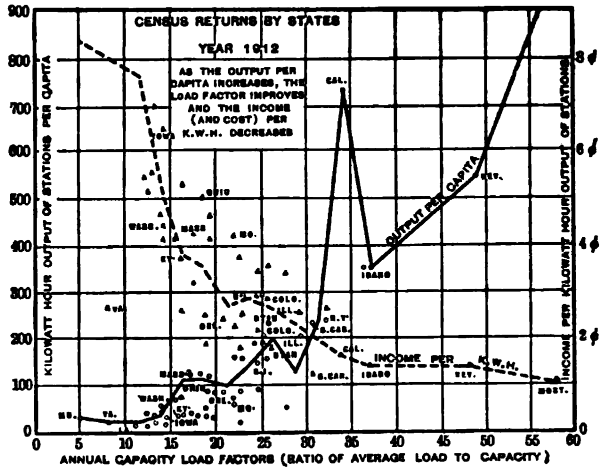


Fig. 15. Relation of Income to Output as Shown by Census Returns

that the rule is almost invariable that as the income per kilowatt-hour goes down, as the output per capita goes up, the cost per kilowatt-hour follows the line of income and the load factor necessarily shows a very decided improvement.

Statistics of Output and Income

It is interesting to note in this chart that the highest output per capita is at Niagara Falls, and the lowest income per kilowatt-hour is also at Niagara Falls. San Francisco, Minneapolis, and Baltimore are all in the area of hydro-electric production, which is supposed to be very much cheaper than production from coal. Chicago, with steam production, is pretty close to the hydro-electric production, both as to low-

ness in income, high point of output per capita, and first-class load factor, the last figure being 43 per cent last year.

For some time we questioned the reliability of these figures and of the law that we thought was shown by them, and so we looked up the Census figures of the United States Government. The Census figures are given for whole states only and, plotted, they show as in Fig. 15. As there was not room to print the names of all the states on the diagram, a tabulation of all the states is given in Table IV. As the maximum demand of the

TABLE IV.—CENSUS RETURNS BY STATES

Name of state	Plant rating load factor	Output per capita in Kw.-hr.	Income per Kw.-hr. in cents
Alabama	22.7	22	2.49
Arizona	25.4	161	3.56
Arkansas	12.4	11	5.45
California	33.9	734	1.59
Colorado	25.3	206	2.89
Connecticut	19.2	117	4.10
Florida	12.5	34	5.11
Georgia	17.8	83	2.01
Idaho	37.0	355	1.37
Illinois	29.3	205	2.52
Indiana	19.9	88	3.26
Iowa	14.4	32	6.45
Kansas	22.0	79	2.19
Kentucky	15.9	33	3.64
Louisiana	10.9	11	12.25
Maine	22.7	158	1.74
Maryland	5.0	21	1.37
Massachusetts	17.5	115	4.17
Michigan	23.2	187	2.19
Minnesota	22.7	90	3.72
Mississippi	14.6	16	4.02
Missouri	21.7	71	4.18
Montana	58.0	1015	1.05
Nebraska	18.6	47	4.98
Nevada	48.6	550	1.38
New Hampshire	25.0	293	1.84
New Jersey	24.4	151	2.85
New Mexico	12.9	28	5.50
New York	32.1	239	2.63
North Carolina	18.7	32	1.90
North Dakota	12.9	21	7.01
Ohio	18.6	84	2.99
Oklahoma	19.7	29	4.54
Oregon	20.7	87	2.39
Pennsylvania	15.7	77	4.14
Rhode Island	18.4	115	3.71
South Carolina	30.7	235	1.24
South Dakota	14.0	42	4.58
Tennessee	17.4	35	3.24
Texas	27.6	52	3.38
Utah	26.0	232	1.75
Vermont	21.9	159	2.07
Virginia	8.1	14	2.65
Washington	14.2	62	4.33
West Virginia	16.1	35	2.60
Wisconsin	24.9	92	2.92
Wyoming	16.1	79	6.24

various plants is not given in the Census figures, we had to base the load factors on the plant rating instead of the maximum demand, but you will find that, relatively, the same rule follows as was shown in the case of the cities. The income per kilowatt-hour goes down pretty steadily, the output per capita goes up pretty steadily, the load factor improves as selling price is lowered, and the output per capita goes up as the selling price is lowered.

I think that Fig. 15 and the table are among the most interesting which we can produce on this subject of the centralization of energy supply. They show that all the great water-power states of the West are in the category of low income per kilowatt-hour, high output per capita, and extremely high load factor. It is extremely interesting to me to note that in a coal state like Illinois, where we have little water-power in proportion to the energy consumed, we are located on this chart right among the water-power states. New York is naturally in that group, because it is brought there by the extraordinary conditions at Niagara Falls.

I think that Fig. 15 is an absolute demonstration of the necessity of monopoly in the production and distribution of energy. Those of you who are familiar with the business will recall the situation in the great water-power states. You will remember that in order to utilize the water-powers that have so far been brought into use it has been necessary in most cases to make installations of great size and requiring large sums of money to defray the cost. The territory is sparsely settled; the industries are relatively few; and the engineers engaged in marketing the product of those expensive water-power plants have to take every class of business within their reach. No one within the area of a water-power on the Pacific slope of the Sierra Nevadas or upon the eastern slope of the Rocky Mountains would think of producing his own power if a transmission line of a water-power company was anywhere within reach, partly owing to the high price of fuel in some of the territory, and partly to the low price quoted for energy by the majority of the large hydro-electric producing companies. The fact

is that, whether it is to operate the copper mines of Montana, or to drive the trains to cross the mountains farther west toward the Pacific Coast, the consumers, instead of having their own individual plants, go in most cases to the hydro-electric companies.

What has been Done in the West can be Done in the East

That condition has gone on throughout the western water-power states for a number of years, simply as a matter of neces-

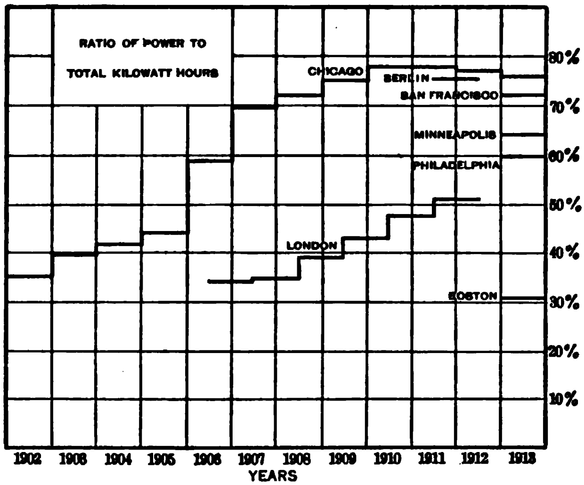


Fig. 16. Diagram Showing Proportion of Motor Load to Total Load

sity. The hydro-electric companies needed the income, and they quoted tariffs that would get the business. As a result, in most of the territories where hydro-electric plants are operated, such a thing as a stationary steam plant is unknown, except under very unusual circumstances. Even on the mountain grades of the trunk-line railroads it will only be a few years before steam power will be unknown to the transportation companies.

It is to produce the same character of concentration of pro-

duction and distribution of energy in the more densely settled portions of the United States, in that portion of the states this side of the Mississippi River, where coal is relatively cheap and yet where it is being used up at such a rate as to jeopard seriously the natural resources of the country, that I am mainly interested in talking to you tonight. All that I am trying to show you is that the character of business done in California, in Idaho, in Nevada, in Montana, and in Colorado, and the other water-power states, should be done in the eastern states in precisely the same way, where coal is the basis of energy, as it is done where water is the basis of energy.

The comparisons of Fig. 16 are interesting simply as showing how relatively unimportant is the lighting in connection with most of the large electric-service companies in this country and in Europe. The diagram shows how the ratio has gone up in a period of years. The top line, that of Chicago, shows 75 per cent; that is the ratio of power (motor load) to the total kilowatt-hours sold, and that would mean, of course, that lighting represents practically the other 25 per cent. Berlin comes next, San Francisco next, Philadelphia next, London next, and so on down to Boston.

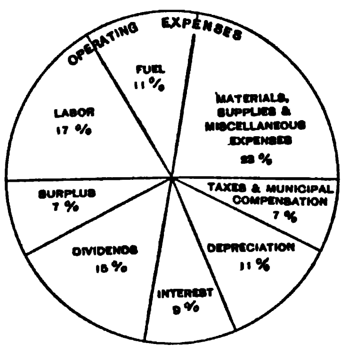


Fig. 17. What was Done with the Dollar of Income in Chicago in 1913

Fig. 17 is interesting in showing what becomes of the money received by electric-service companies, which has some bearing on the cost of our product and our selling price. This chart represents the operations of a company which has an income of about $17,000,000 a year. You will notice that one-half of the cost is that of labor, fuel, materials, supplies, and miscellaneous expenses. Taxes and municipal compensation amount to 7 per cent. To the layman the fact that the fuel costs only 11 per cent while the right to do business takes 7 per cent may seem to be somewhat unusual.

You will notice that one-half of all the expense represents the cost of money and the right to do business. Thus, 11 cents out of every dollar goes for depreciation; 9 cents out of every dollar received goes for interest on bonds; 15 cents per dollar of income is paid out as dividends on capital stock. The two together represent about 6 per cent on the money invested in

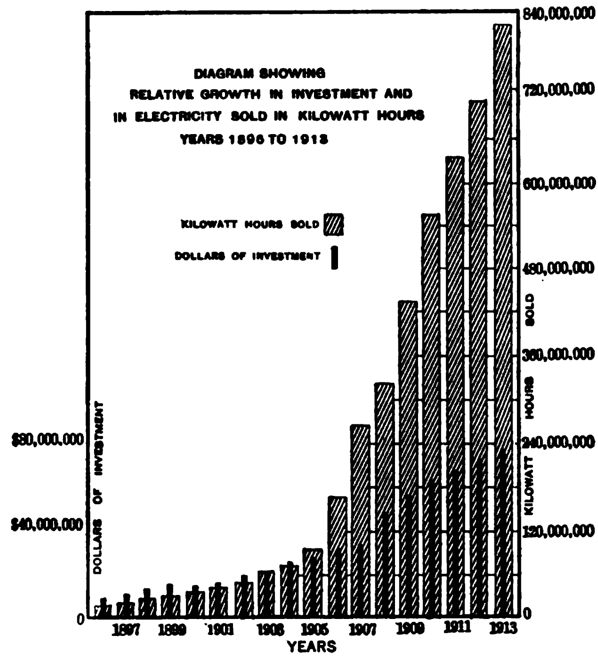


Fig. 18. Ratio of Investment to Output in Chicago

the property. Seven per cent surplus is set aside, partly from the work of the selling engineer in improving earning capacity on the money invested.

Relative growth in investment and in electricity sold in kilowatt-hours for the years 1896 to 1913 is shown in Fig. 18. The solid vertical lines represent dollars, and the shaded portions represent the kilowatt-hours sold. I do not know that I can better tell the story of the concentration of power supply

than that chart does. In 1903 the kilowatt-hours sold was somewhere about 60,000,000, and you go on to 1913 and the number of kilowatt-hours sold is nearly 840,000,000. I would call that change the saturation of the dollar. It shows what can be done by concentrating production for all purposes, and as a result improving the diversity factor and improving the load factor.

Generally the additions to plant provided out of reserves amount to the proportion of about three dollars for every two

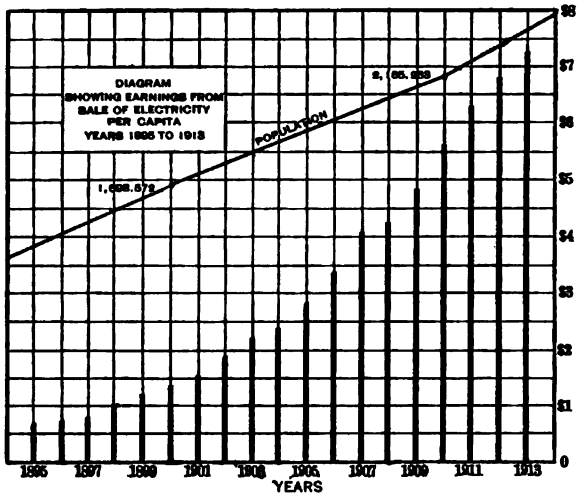


Fig. 19. Per Capita Sales in Chicago

dollars that is supplied from new capital. That gives you some idea of the stability of the investment.[1]

In Fig. 19 are shown the earnings from the sale of electricity per capita for the years 1895 to 1913. It follows practically, and must necessarily follow, the curve (Fig. 18) which shows the relation of investment to output.

Fig. 20 should be of interest to everybody, whether he uses electricity or not. One of the great, vital questions before us is the question of the conservation of our natural resources.

1. Mr. Insull's point here is shown in Fig. 6 of chapter on "Electrical Securities," page 435.

These curves give the pounds of coal burned by this electric-service company per kilowatt-hour, the kilowatt-hours generated and the number of tons of coal burned. As the years have gone by, from 1900 to 1913, we have dropped from nearly seven pounds of coal per kilowatt-hour to 2.87 pounds. As a result, notwithstanding the great increase in our output, the tons of coal burned do not increase in any such proportion. That tendency is going on continuously, partly from the work of the inventor, partly from the work of the designing engineer, and partly from the work of the selling engineer in improving

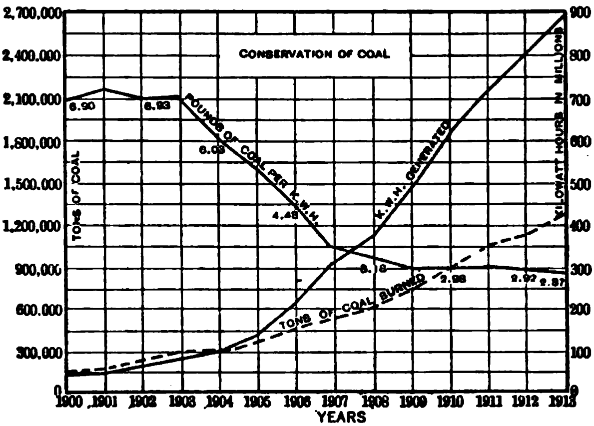


Fig. 20

the character of our load. In my judgment, in the next few years, the pounds of coal per kilowatt-hour will drop something like twenty-five to thirty-five per cent, which necessarily must have an important bearing upon the value of water-powers, especially in territory where water-powers have low head, and consequently have relatively high investment in proportion to their product.

Fig. 21 is really a balance sheet. It is taking the figures from annual balance sheets and plotting them as curves. It is the index as to whether the business of supplying energy is run economically. You will notice that notwithstanding that the income per kilowatt-hour sold goes down very steadily

in the course of five years, the income per dollar of investment goes up steadily. During the same time, the cost per kilowatt-hour sold goes very steadily down, dropping practically one cent, and follows the line of income. That cost includes operating expenses, interest and depreciation. The "net earnings per dollar of investment" line goes steadily up.

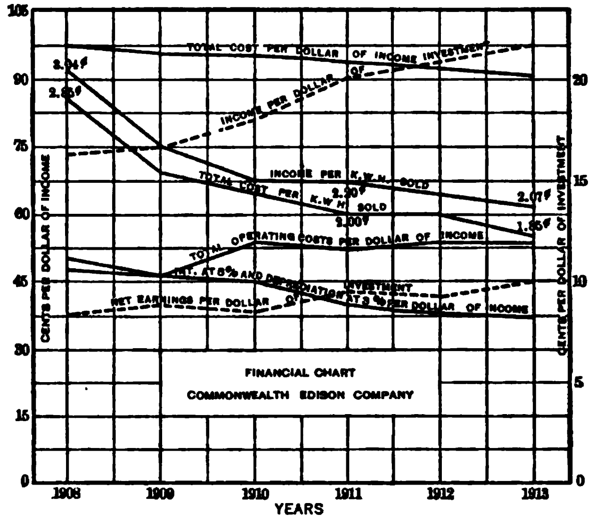


Fig. 21

Some of the Practical Benefits of Concentration

In the previous charts I have given you some of the results of the centralization of energy production and distribution in a large center of population. As I stated at the beginning, I have naturally taken the figures of the company in Chicago of which I am the head. They were the most available for my purpose, and I naturally am able to make such use of them as seems necessary, which I might not feel at liberty to do with the figures relating to companies managed by some of my friends.

Purposely I kept the transportation business out of any of the charts that I present to you this evening. We generate in Chicago nearly one thousand million units (kilowatt-hours),

and a little over one-half of our annual product is sold to the local transportation companies. Except so far as the production of that energy has a bearing upon our total cost and our total income, and our income per dollar of investment, I have refrained from discussing the income from transportation, or the output on account of transportation.

I wanted to show you how it was possible to get a large diversity of business, having an extremely good load factor, in territory where, for one reason or another, it does not seem possible to combine all the production of energy for all classes of business. I might follow the subject still further, and show you the advantages alike to the transportation companies and to the energy-producing companies, and to the community itself in massing all classes of business, as I stated in my opening remarks it was necessary to do if you desire to get the highest possible efficiency in production and the highest possible efficiency in earning capacity on the money invested.

[Mr. Insull here repeated some of the data and estimates in relation to concentration of energy supply in the state of Illinois, as given in his Franklin Institute address, which is begun, in this volume, on page 357.]

Fig. 22 shows the territory in Illinois which I have the privilege of operating. This territory extends from the Mississippi River on the west almost to Terre Haute, Indiana, on the east. The method of distribution is to place the generating stations in centers where there is relatively a large amount of energy required, or where the energy can be produced very cheaply. For instance, there were originally in this whole territory 63 stations; we now have but 30, and expect ultimately to have only seven or eight. The main centers of supply are at Mattoon, at Kincaid at the mouth of the coal mines, at Beardstown, at Belvidere, and several other places, and in addition we take energy from the Keokuk hydro-electric plant on the Mississippi River.

This is probably as good an illustration as I can present to you of the group operation of properties, typifying the production and distribution on the basis of concentration. There

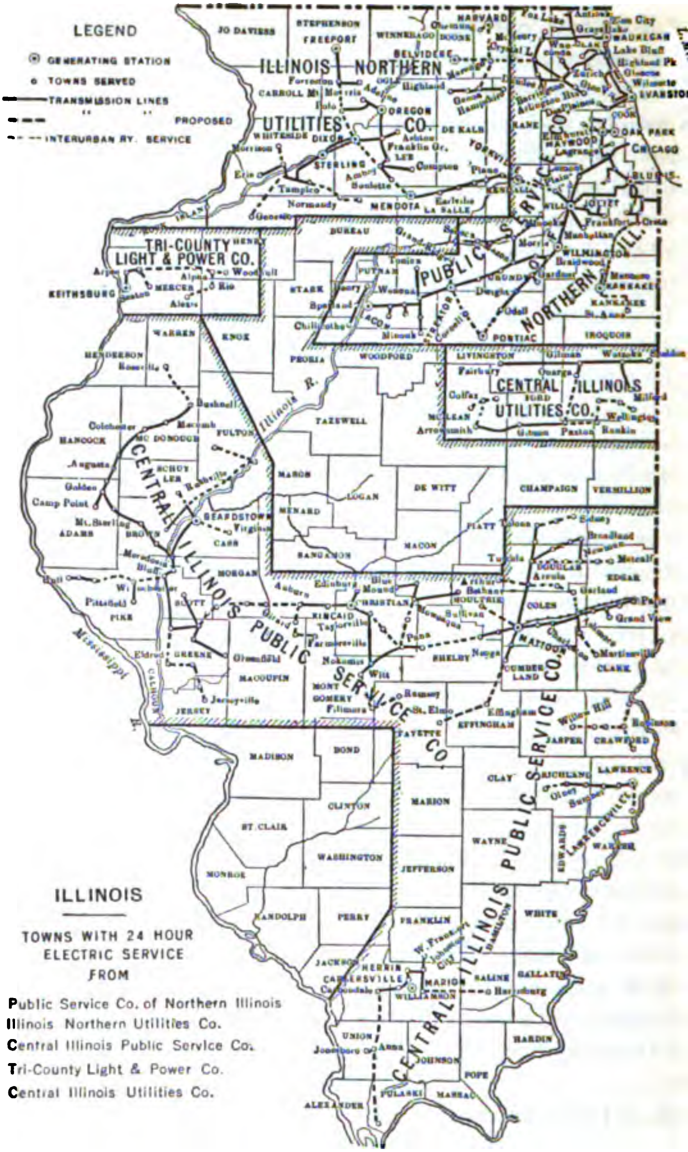


Fig. 22. Map of Illinois, Illustrating Group Operation of Public-Utility Properties (1914)

are some other properties, of which I have not the figures, operated in groups, centered at Peoria and Springfield, and some other groups in different parts of the territory that are owned by other people.

Even in so densely settled a state as Illinois, having such marvelous wealth above ground and below ground, the energy supply is confined to 48 per cent of the population. The population that I am particularly interested in at this time is the other 52 per cent.

Monopoly, Regulation, Fair Treatment on Both Sides — These are Essential

This must be a monopoly business, if it is to be run on economic principles. The sound economics of it are those of monopoly, and, as I have said, it is an unreasonable thing to expect that the community, whether it be the local community, or the state or the nation, should allow business of this character to go on without being regulated; but, assuming that the regulation is intelligent, the investor has nothing to fear, the user has nothing to fear. If companies operating over large areas have not the good judgment to run their business in such a way as to square with public opinion, the commissions that exist throughout most of the states today are ready to protect the users of the product. If the communities are so ill-advised as to be guilty of unfairness to those who put their money into these properties, the commissions are there to protect the investor.

My own judgment is that the very best thing that has happened to our industry — it is an inconvenience to men like myself, dealing with a large number of properties in various parts of the country — but the very best thing that has happened to our industry as a whole within the last few years has been the creation of commissions to regulate the electric generating and distribution business and kindred interests.

I believe that, in the long run, regulation means protection. I know to a great many people that does not seem to be a very

popular side of things at this time, in view of the treatment, or the alleged treatment, the railroads are receiving at the hands of the Interstate Commerce Commission; but I have a firm conviction that the best thing for our securities, the best thing for the widows and orphans who buy them, and the best thing for us, is that we should stand firmly on the basis that our business must be a monopoly. We should recognize the fact, if it is a monopoly, that it should be regulated, and then we should insist on getting fair treatment, and in order to get fair treatment we must be fair to those with whom we are dealing.

In my judgment, within the next few years there will scarcely be a spot in the densely settled portions of the country, and especially between here and, say, the central portion of the Mississippi Valley, where you will be unable to get electric service for all purposes at all times from a central system of generation and distribution.

I think it was my friend Dr. Steinmetz who, in a recent lecture, drew a picture of the transmission lines of the future running across the country something like the trunk lines of our transportation systems.

We are engaged in a business that probably has a more intimate relation to more classes of people and to greater numbers in the community than any other line of public service, governmental or private.

There is no reason whatever why the wheels of industry, the avenues of transportation, the homes of the poorest, and all other classes of human endeavor should not add to the greatness of the business of the generation and distribution of electrical energy.

Sometimes we hear (as we heard a representative from my own state recently in the halls of Congress) someone decry the fact that there is no competition in a business where the price is fixed by a body appointed under an act of the Legislature by the governor of the state — a business which cannot be run economically except as a monopoly. Remarks of that kind cannot possibly be made by anyone understanding the

true economics of the situation. I think that much can be done in the direction of the conservation of resources, in lessening the severe conditions of labor, in improving the conditions of our people by opening up our rural districts to manufacturers, where there is any considerable density of population; in fact, there is scarcely a direction in which one can look without seeing possibilities of development in connection with what is really the juvenile industry in public service and yet the greatest industry in public service today.

I am not speaking to an audience of engineers only, but to an audience with a strong sprinkling of young men, to those who form the great body who have the destinies of this country in their hands. There is no blow that you can deal to your motherland, there is no greater injury that you can do to yourselves, than to deal unfairly with the great public-service enterprises that have built up this wonderful republic. I think that if nothing else is accomplished by my friends and myself, in appearing before you, than to give you a better conception of what the leaders in the industry are after than you ordinarily receive from reading the flippant remarks in the average daily newspaper, we will have rendered you as well as ourselves a great service.

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